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4-6-0 Type Locomotive on Hungarian State Railways

With Brotan-boiler, Loop Water-preheater and Purifier Pecz-Rejtö System

By Desider Ledacs Kiss, Mechanical Engineer, Budapest

In 1918 traffic on the Hungarian State Railways increased so much that it was necessary to increase the capacity of the motive power about 30 per cent which led to the construction of the ten-wheel type locomotive (series 328) described in this article. Because of the scarcity of copper occasioned by the world-war, these locomotives were constructed with boilers of the Brotan system.

ROYAL HUNGARIAN STATE RAILWAYS 4-6-0 TYPE EXPRESS LOCOMOTIVE EQUIPPED WITH BROTAN BOILER, WATER TUBE FIREBOX, LOOP WATER PURIFIER AND PREHEATER

This type of boiler is equipped with a water tube firebox, which was applied with excellent success on the locomotives on the Hungarian State Railway in 1908. It was first used on the Hungarian State Railways and the Austrian State Railways at about the same time. In fact, the development of the Brotan System of water tube firebox to its present stage may be largely credited to the Hungarian State Railways that have perfected this type of construction to a greater degree than any other railway system.

Locomotive boilers of the Brotan type are a combination of water tube and fire tube construction. The upper part of the firebox consisting of a horizontal cylindrical drum. The earlier and later types of this construction are represented, respectively, in Fig. 1. and Fig. 2. in which (a) is the so-called preliminary boiler while (b) is the foundation ring. This foundation ring is a steel casting. Connection between the preliminary boiler and the foundation ring is by means of the Brotan tubes (c), placed closely together in a row so as to form the side and back walls of the firebox and the front wall of the tube sheet (d). The Brotan tubes used in these fireboxes are made by the Mannesmann process.

To create a vigorous circulation of the water through the firebox, the foundation ring is connected to the underside of the barrel of the boiler by at least two elbows (e) so that the water flows freely into the foundation ring and thence rises rapidly in the highly heated Brotan tubes that

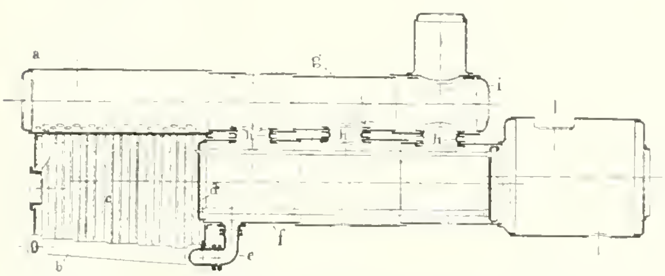
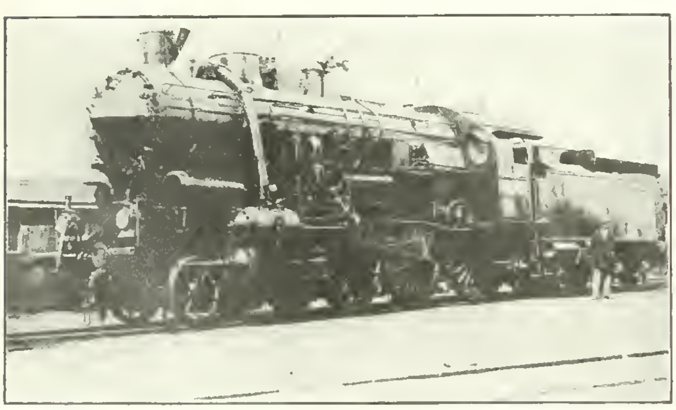


FIG. 1. TYPICAL CROSS SECTION OF EARLY TYPE OF BROTAN LOCOMOTIVE BOILER WITH WATER TUBE FIREBOX

constitute the side walls of the firebox and evaporates into steam in the preliminary boiler (a). Due largely to this vigorous circulation, the Brotan boilers have proved more efficient than the ordinary locomotive boilers and tests conducted on the Hungarian State Railways have shown an economy of 8-15 per cent in fuel consumption with the Brotan fireboxes in comparison with plain locomotive fireboxes.

In the earlier type of Brotan boilers as illustrated in Fig. 1. a smaller diameter boiler (g) was placed above the main barrel of the boiler (f) which was equipped with fire tubes and a smoke box in the front end. The upper



4-6-0 TYPE EXPRESS LOCOMOTIVE FOR HUNGARIAN STATE RAILWAYS BUILT AT THE STATE RAILWAY SHOPS

drum (g) was connected by several circular connections (h) to the lower or main barrel of the boiler (f). The Brotan tubes forming the walls of the firebox were rolled into the overhead drum (g) and the mean water level corresponded with the center line of this drum, so that the lower or main barrel of the boiler (f) was entirely filled with water. In this construction, however, it was soon found that the evaporating surface at the water line, the reduction in area and that the agitation of the water in the upper drum (g) caused too high a moisture content in the steam. To remedy this defect by increasing the evaporating surface of the water line, the subsequent type of Brotan boiler as shown in Fig. 2 was evolved. This change in design greatly simplified the construction of the boiler and reduced its cost as well as its weight. With this later design the moisture content in the steam has been greatly reduced; although, as will be described later in this article, steam desaturators are ordinarily used in these locomotives.

In the later Brotan firebox designs the maintenance problem has been much simplified due to the use of tubes curved to a larger radius which lessened their liability to leak where rolled into the preliminary drum (a). When the latter type of Brotan firebox as shown in Fig. 2 was

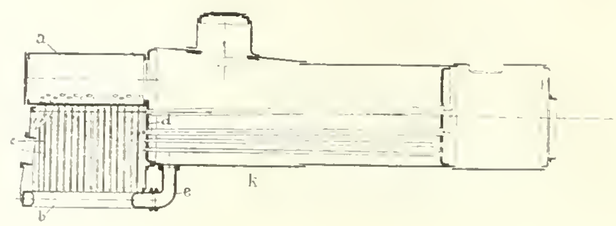


FIG 2. TYPICAL CROSS SECTION OF MODERN TYPE OF A SMALL BROTAN LOCOMOTIVE BOILER WITH WATER TUBE FIREBOX

first developed, the Hungarian State Railways employed a conical shaped section in the last course (k) of the main boiler barrel. With the steam dome mounted on this conical course it was possible to get dry steam but the long dry pipe required and the waste in boiler plate occasioned by cutting this sheet for a conical section have led the Hungarian State Railways to adopt a straight cylindrical boiler shell in their most recent locomotive construction, of which this ten-wheel type passenger locomotive is an example.

These ten-wheel type locomotives are the first passenger locomotives on the Hungarian State Railways, however, to be equipped with the Brotan type firebox as illustrated in the accompanying drawings. It will be noted that in these boilers the boiler shell immediately in advance of the firebox tube plate is cylindrical instead of conical and in this respect marks a departure from previous boilers of the Brotan type, being the first of this design to be built.

The thickness of the inside main frame of ingot-iron is 1 7/64-ins. suitably provided with stiffening plates. The center bearing of the leading truck does not carry any of the weight of the locomotives, this being transmitted to the truck frames by means of truck side bearings. In order to facilitate curving, the truck has a lateral play of 2 13/32-ins. and is restored to its central position by two flat centering springs. Also to facilitate operation of sharp radius curves, the gage of the driving wheels is ½-in. less than the normal distance between flanges as will be noted in the drawings. All the axles and cranks of the locomotive are bored out in order to be tested internally.

The firebox is placed above the last coupled wheels and is much wider than the frame. With a driving wheel diameter of 72-in. it will be noted that the design of this wide firebox presented a difficult problem. In order to protect the last pair of driving wheels from the radiant heat of the burning coal upon the grates, in the firebox immediately above the wheels, protector plates were applied. And to avoid dead grate surface, it was found necessary to have built upon them a sort of multi-stage

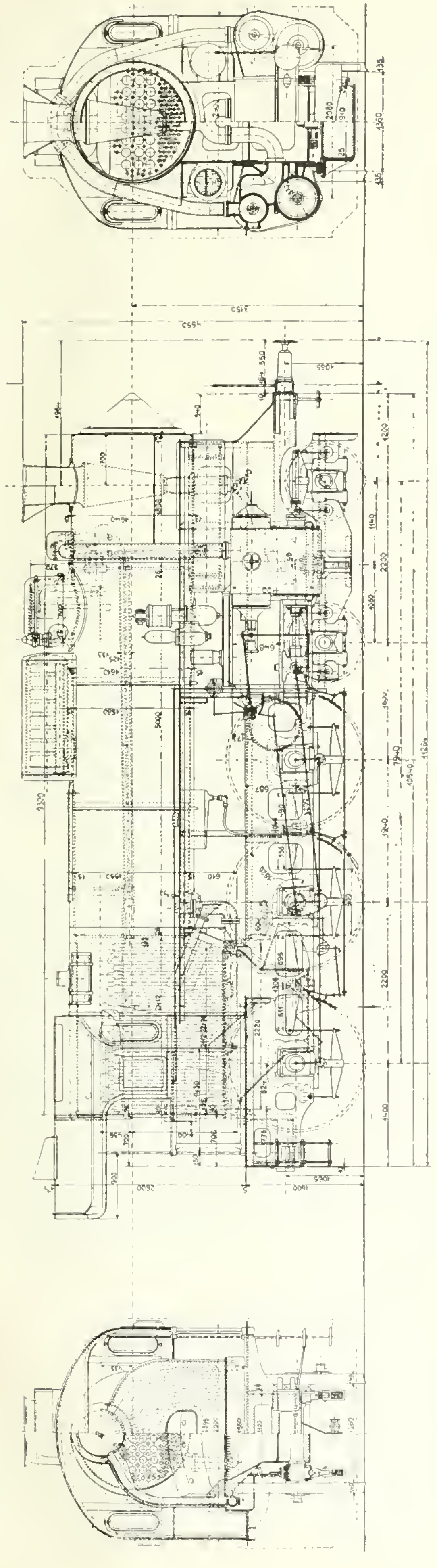


FIG. 3. ELEVATION AND SECTIONAL VIEWS OF STANDARD 4-6-0 TYPE LOCOMOTIVE OF THE HUNGARIAN STATE RAILWAYS EQUIPPED WITH BROTAN BOILER, LOOP WATER PURIFIER AND PREHEATER PECZ REJTO SYSTEM

grate. The forward part of the firebox has a drop-grate.

The firebox design also includes a semi-automatic smoke consumer which operates on the principle of admitting air through four passages in the brick arch above the grate.

To afford the circulation of water, the firebox ring of the Brotan type boiler is connected with the last shell of the boiler barrel. The plates comprising the boiler shell are both welded and riveted together. The barrel of the boiler consists of three courses made of ingot-iron plates of 19/32-in. thickness. The steam dome containing a balanced slide valve for throttling the steam is located on the first course. On this steam dome there are placed two pop valves of 3½-ins. diameter.

A feed-water purifier with eight cells is located over the second boiler course. This apparatus is also designed under the Pecz-Rejtö patent and is standard equipment on the Hungarian State Railways. The performance of this device has proven so very satisfactory that it is now in general use not only on new locomotives but on many old locomotives and at the present time there are about 3,000 locomotives equipped with this device.

The Hungarian State Railways employed first the loop water purifiers in 1910 and from 1912 every new locomotive was equipped with it. By the use of this water purifier the problem of boiler preservation from the scale can be considered as solved. The feed water comes directly in the water purifier, this being in connection with the steam-room, thus the feed-water can be heated to the suitable degree of heat. The scale forming impurities are precipitated mostly in the water purifier, the water coming in the boiler contains only such solid components which form in the boiler a muddy sediment and can be removed by means of blowing it off regularly, at the washing out of the boiler the remained pulpy sediment can be washed out with a single spurt.

The steam box contains a body with several cells fastened on the middle tube, the whole body with the cover can be drawn out for cleaning. The purifiers have 4-6-8-10 and 12 (2-ins. x 6-ins.) cells according to the steam generating power of the boilers.

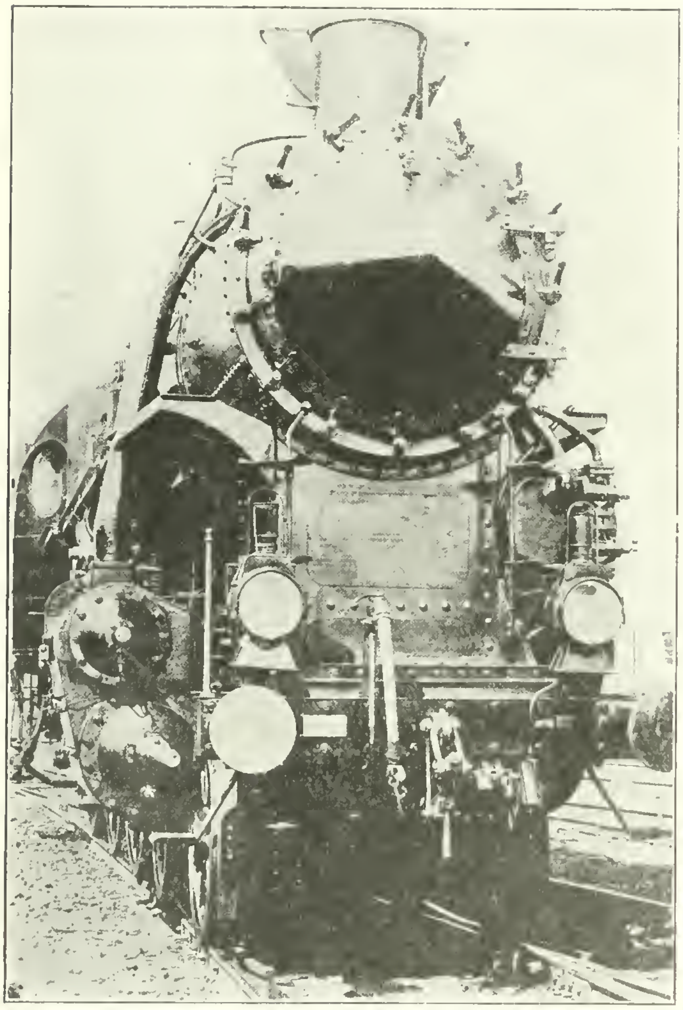
The cleaning of the locomotives provided with water purifiers require cleaning at intervals 8 to 10 times less frequently than those not so equipped. Fast passenger locomotives without water purifiers require cleaning after running 360 to 600 miles while those equipped with water purifiers run 5,000 to 10,000 miles without cleaning. If we consider the time saved, those without purifiers require cleaning every 3 to 4 days, with the purifier they run 1 to 2 months from cleaning to cleaning. Likewise the second-class and freight train locomotives without purifiers the cleaning must take place after running 250 to 300 miles or at the intervals of 4 to 7 days, while those provided with purifiers, can run 2,700 to 5,000 miles or during 1 to 3 months without cleaning.

At the conclusion of peace hundreds of locomotives remained in the possession of Roumania, which were provided with Pecz-Rejtö's feed water purifiers. Moreover, the Roumanians seized in 1919 more than 1,500 locomotives from Hungary, on which the before said feed water purifiers were likewise employed. Thus the Roumanian State Railways had the occasion to make comparisons between the locomotives with and without feed water purifiers, the result of which was that the Roumanian State Railways ordered the equipment of all the locomotives with Pecz-Rejtö water purifiers. We show an interesting type of the locomotive with Pecz-Rejtö feed water purifier.

With a view to lessening the front end air resistance, the smoke box door on these ten-wheel locomotives is cone-shaped and front end of the engineer's cab has been made wedge-shape as will be observed in the accompanying illustrations of this locomotive.

The piston valves are provided with narrow packing rings and are controlled by the Walschaerts valve gear. The cylinders are fitted with relief valves, with a by-pass valve for drifting and with a compression valve.

The locomotive equipment includes a centrifugal water intercepting device or steam desaturator of the Stein system placed in the dome, a lubricating apparatus of the Friedmann system, an electric pyrometer of the Siemens-Halske system, a pneumatic sanding system of the Hungarian State Railway Standard, a Friedmann automatic "Triplex" steam heat reducing valve, Westinghouse brake apparatus, Hausshäller speed recorder, Krolupper acetylene cab lamps, two Friedmann No. 11 injectors, and a Knorr feed valve heating system.



HEAD END VIEW OF 4-6-0 TYPE LOCOMOTIVE OF THE HUNGARIAN STATE RAILWAYS

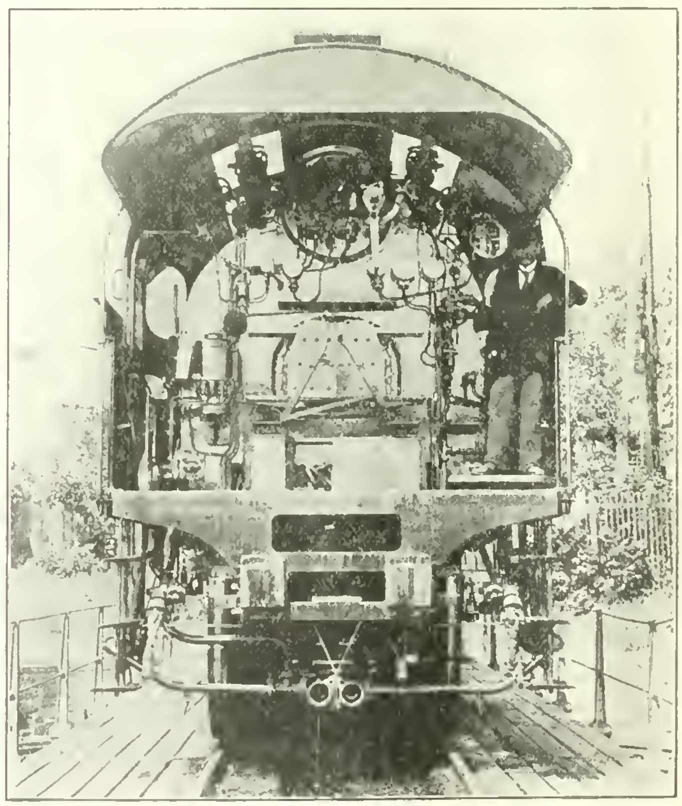
The flanges of the forward driving wheels are lubricated by the condensation water from the Knorr feed-water pump in the system. The application of the Pecz-Rejtö locomotive feed-water heating apparatus to these locomotives was decided upon after a test of this equipment had been made on the Hungarian State Railways passenger and freight locomotives of the 2-6-2 type (Series 324.) which demonstrated such good economies that their use on these new locomotives was justified.

The Pecz-Rejtö feed-water preheating apparatus as applied to these locomotives consists of two pre-heating cylinders, one located on the right hand and the other on the left hand side of the locomotive. These are connected and serve for pre-heating the feed-water by the exhaust steam. Its purpose is to impart to the feed-water the temperature of the exhaust steam diverted from the exhaust passage of the locomotive. Experience on the Hungarian State Railways has proved that if one-fifth of the exhaust steam from the locomotive cylinders is diverted to the feed-water heater, it will have no appreciable effect on the draft of the locomotive. The heating cylinders located separately in the apparatus. In addition to this, the right-hand and left-hand heaters receive the exhaust steam from the Knorr feed-water pump. The partially condensed steam from these pre-heaters is drained underneath the boiler.

The feeding of the boiler is accomplished by the single feed-water pump and two Friedmann injectors. The left-hand injector and feed pump conveys the feed-water through the pre-heating device, i.e., the water runs through the injector or feed pump first into the left-hand and then into the right-hand pre-heating cylinder and from there passes through the water purifier into the boiler. This method of operation is used because it has proved the most economical.

When the right-hand injector is used the feed-water runs only through the water purifier and then direct to the boiler.

With the Knorr duplex feed pump, the water cylinder has a steam heating jacket, wherein also the exhaust steam of the pump is conducted. On the up-stroke of the piston the water enters through the right side suction valve and at the same time pushes the water from the upper cylinder



CAB INTERIOR VIEW OF STANDARD 4-6-0 TYPE LOCOMOTIVE OF THE HUNGARIAN STATE RAILWAYS

chamber through the left side delivery valve into the delivery pipe and vice-versa, the left side suction valve and the right side delivery valve are actuated on the down stroke. The maximum capacity of the pump is 80 gallons per minute. The pre-heating cylinders are filled entirely with straight tubes through which the feed-water makes two passes. The exhaust steam chamber is also partitioned so that the steam flows from one end of the heater to the other and back to the course of the feed-water.

In order to eliminate the water of condensation together with the mud which eventually settles in the base of the heater, suitable valves and wash-out fixtures are provided.

Two locomotives have "Worthington" feed-water pump from Tendoff-Dittrich at Budapest.

Key to elevation drawing showing feed water apparatus on new Hungarian State Ry., ten-wheel type locomotives.

A.—Suction pipe of the left side injector.
B.—Pressure pipe from the feed pump to its head.
C.— " " " " left side injector to its supply head.
D.— " " " " supply head to the left preheater.
E.— " " " " left preheater to the right preheater.
F.— " " " " right preheater to the water purifier.
G.— " " " " right side injector to the water purifier.
H.—Steam pipe from the cylinder exhaust to the preheater.
I.— " " " " exhaust of the feed pump to the preheater.
J.—Steam pipe from the exhaust of the Westinghouse airpump to the preheater.
K.—Steam pipe from the preheater to discharge.
M.— " " in boiler from the steam dome to the throttle valve.
N.—Steam pipe from the steam valve to the feed pump.

Tubes, number and diameter	120—2 ins.
Flues, number and diameter	24—5¼ ins.
Tubes and flues, length	16 ft. 5 ins.
Heating surface, firebox	74.3 sq. ft.
Heating surface, tubes	1059.1 sq. ft.
Heating surface, flues	539.2 sq. ft.
Total evaporative surface	1772.6 sq. ft.
Superheating surface	486.5 sq. ft.
Feedwater heating surface	205.6 sq. ft.
Grate area	35 sq. ft.
Total weight in service	155,756 lbs.
Cylinder horsepower (theoretical)	1,594
Boiler horsepower (theoretical)	1,235
Percentage, boiler to cylinder hp.	77
Weight per boiler h.p.	126 lbs.
Weight per cylinder h.p.	98 lbs.

Importance of Correct Design for Industrial Locomotives

The industrial locomotive is frequently considered as a "stock proposition" which requires very little special designing. This point of view is not always the correct one, because the successful industrial locomotive represents a class by itself. Careful attention to the special points of design is necessary for a machine working under conditions entirely dissimilar from those found in main line work. Frequently the industrial locomotive used around a factory, plantation or in public works, does not have the careful attention nor the facilities for repair that are given to a standard railway locomotive. It is, therefore, highly necessary that it should be built in a simple and rugged manner and that its details be given extra strength and wearing qualities. Furthermore, it should be so arranged as to give maximum convenience to the enginemen. In fact, on small operations there is frequently but one operator who acts as both driver and fireman. Under such circumstances it will be appreciated that convenience of all the necessary controls is a feature that cannot be too strongly emphasized.

As these locomotives are frequently operated on very rough or poorly laid track, it is also highly essential that their weight be properly distributed, and that a simple and positive system of equalizing levers be attached to their spring rigging.

So far as possible, the industrial engine should have a low center of gravity to take care of track unevenness and to provide safety with a minimum of destructive effect upon the tracks.

The wheelbase should be of sufficient length and the overhang at each end in such proportion to the wheelbase as to preserve perfect balance and to keep the engine

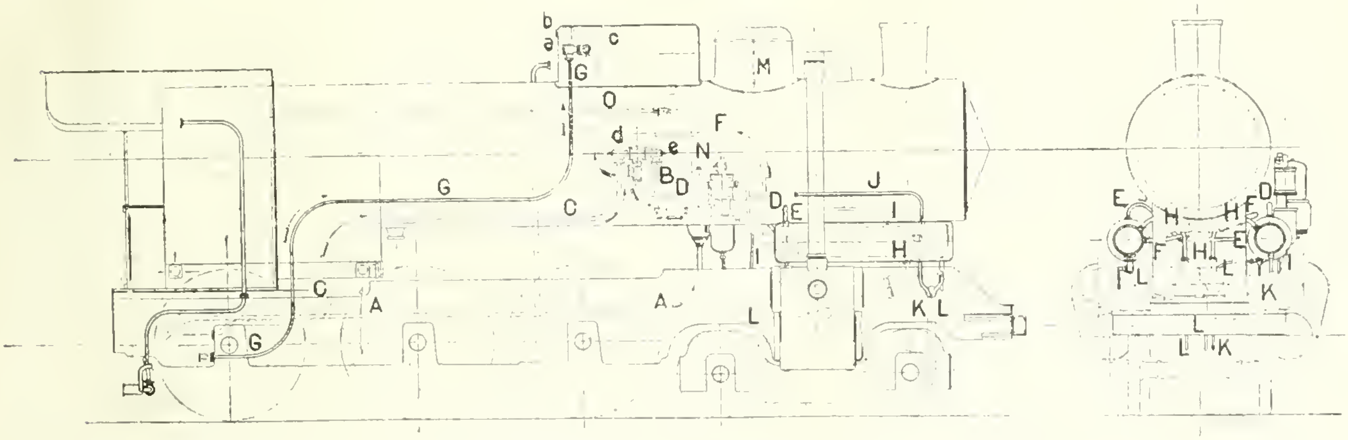


FIG. 4. ELEVATION DRAWING SHOWING FEED WATER APPARATUS ON NEW HUNGARIAN STATE RAILWAYS 4-6-0 TYPE LOCOMOTIVE

The locomotive tender has two four-wheel trucks. The capacity of the tender is 5,300 gallons and eight tons of coal.

The locomotive is designed to pull a train of 400 tons weight behind the engine and tender, at a speed of 50 miles per hour, developing about 1,430 horsepower at this speed. During the trial trip this locomotive actually hauled a train of 400 tons weight with a velocity of 55.92 miles per hour. In another instance this locomotive pulled its full capacity of 470 tons up a .7 per cent per mile grade at a speed of 31 miles per hour and 73 tons at a speed of 75.8 miles per hour. The first two locomotives of this type were completed in December, 1919, but were subsequently seized by the Roumanians (Oliaken) together with about 1,500 other locomotives and several thousands of freight cars. Tschecho-Slovaka has also taken 17 of these new locomotives, of which the Royal Hungarian State Railways are building 58 at their shops in Budapest. Henschol and Sohn at Cassel are also building 83 of these locomotives for the Hungarian State Railways and 17 for the Tschecho-Slovaken State Railways.

The principal dimensions of the new standard ten-wheel type locomotives for Hungarian State Railways follow:

Maximum tractive effort	26,000 lbs.
Cylinder diameter	22.4 ins.
Cylinder stroke	22.6 ins.
Driving wheel diameter	72 ins.
Boiler pressure per sq. in.	176.7 lbs.

from rocking and nosing while they are under headway.

A clear view should be given both forward and backward for the engineman, so that the operation of coupling can be successfully accomplished with minimum risk to life and property.

The selection of materials that enter into the construction of an individual locomotive is of equal importance with the design.

The importance of a good view for the track ahead of the running train is always to be considered.

Insufficient size for bearings is one of the most serious defects in an industrial engine. Many lightly built machines of this type are continually giving bearing troubles.

The controls for starting and stopping are also features to be wisely considered. For the stopping of the train the brakes are highly important. Nearly all industrial engines operate trains of cars which are not equipped with braking devices, which condition places upon the locomotive brakes the control of the entire train.

Lubrication is a most important feature in the operation of any locomotive, particularly a machine that is in rough and intermittent service and receives a minimum amount of care and attention. The cylinder lubrication is accomplished by a sight feed condensing lubricator located in the cab. The "condensing" system of lubrication is admitted to be much more positive and economical than the mechanical pump system.

One convenient feature of the cab arrangement is the ample room given for firing, this being so arranged that a minimum amount of exertion is required to shovel fuel from the coal bunker into the fire door.

With a view to economy in fuel consumption rocking grates are supplied. These should be supplied with interlocking fingers which should break up the clinkers and which allow the shaking of the fire during the operation of the locomotive. A dump grate is sometimes arranged at one end, so that the cleaning of the entire fire can be quickly and conveniently accomplished.

The local features governing any industrial operation contribute not only to the detailed character of the locomotive design but also to the character of its accessories.

If air brakes or air operated dump cars are used in the train, the engine can be equipped with the proper compressor and braking system necessary for the service. Where the water supply is otherwise unprovided, a special siphon device for drawing water from wayside sources can be supplied.

When the locomotive is desired to furnish an added protection to the plant around which it operates, it can be equipped with a fire extinguisher complete with hose and nozzle and ready for instant service. These are only a few examples of special features that can be incorporated.

It is advisable that all who require industrial locomotives give most careful consideration to the analysis of their operating conditions and transmit a complete description to the builders when they forward their inquiries.—*Baldwin Locomotives.*

A. R. A. Mechanical Division Meeting and Committees

Since the decision of the American Railway Association's Mechanical Division General Committee not to hold a convention in 1923, with the usual exhibit of equipment, but instead to have a business meeting lasting only two or three days, the division's general committee has appointed the general, nominating and standing committees to serve until June, 1923.

Following a suggestion from the association's executive committee, that a thorough survey be made so as to adjust the committees along the most efficient and economical lines, several committees have been consolidated, others eliminated and the personnel of others reduced.

In addition to the general and nominating committees, the following standing committees were appointed, and were given alphabetical designation as well as names: A, Arbitration; A-1, Prices for labor and materials; B, Autogenous and electric welding; C, Car construction; C-1, Brakes and brake equipment; C-2, Couplers and draft gears; D, Design of shops and locomotive terminals; E, Electric rolling stock; F, Loading rules; G, Locomotive and car lighting; H, Locomotive design and construction; I, Safety appliances; J, Specifications and tests for materials; K, Tank cars; L, Wheels. Those committees having a number after the designating letter are to be considered as part of the committee whose letter they bear, and the chairmen of such committees will be expected to attend meetings of the main committee.

The committees on brake shoe and brake beam equipment, and train brake and signal equipment, were consolidated as the committee on brakes and brake equipment. The committees on car repair shop layouts, locomotive terminals design and operation, modernization of stationary boiler plants, and scheduling of equipment through repair shops, were consolidated as the committee on design of shops and locomotive terminals. The committees on locomotive headlights and classification lamps, and train lighting and equipment were consolidated as the committee on locomotive and car lighting. The committees on locomotive construction, mechanical stokers, feed water heaters for locomotives, lateral motion on locomotives, and design and maintenance of locomotive boilers, were consolidated as the committee on locomotive design and construction.

It is probable that the proposed business meeting will be held in Chicago or some place other than Atlantic City.

Russian Railroads Doing Better

There has been an increase in the number of working locomotives in Russia since last winter. The percentage of disabled locomotives has declined from 64.4 per cent of the total in February to 59.4 per cent in August of the current year, while the number of unsound locomotives dropped from 12,295 in February to 11,418 in August, according to Soviet publications received by the Department of Commerce.

The arrival of 529 new locomotives from abroad has considerably strengthened the working capacity of the railroads. Whether this improvement will hold during the coming winter is a matter of conjecture. The cold weather, the change from one kind of fuel to another and the use of moist wood, distant transfers from one road to another, and other conditions make the situation very uncertain and may result in the exhaustion of the present reserve of 1,500 locomotives. Considering, however, the number of new locomotives yet to be received from abroad, a crisis should be averted provided the present rate of repairing—700 to 800 engines per month—is maintained.

The new locomotives being furnished to the Russian Soviet Government from abroad are built by Nydquist & Holm, of Sweden, who have a contract to build 1,000 locomotives of the 0-10-0 type.

The freight car situation continues precarious. Irrespective of the extent of the execution of the programme of freight car repairs, the situation in regard to sound cars is becoming worse each month. It was planned to make repairs on from 8,000 to 12,000 cars each month beginning with January, 1922, but repairs were actually made on from 6,000 to 11,000 cars, an average of 88 per cent of the repairs planned.

The Railway Specialist or Expert

A Consideration of Their Service to Railways

By W. E. Symons, Consulting Engineer

In the earlier history of our railways the specialist was scarcely known, for the obvious reason that owing to the limited mileage and less intricate problems of operation and finance, the owners and officers in charge of various lines seldom felt the necessity of going outside their own organization for talent.

For many years past, however, the necessity and demand for outside talent has grown wonderfully, until at the present time the bankers who own or finance railway companies, the executives and administrative officers who establish and execute policies, are often largely dependent on the results of investigations, study and conclusions reached by outside or neutral experts in solving important problems of finance, constructions, betterment, operation, maintenance, depreciation, efficiency, etc.

A specialist or expert has a wonderful potential power for *good* or *evil*, hence great care must be exercised in their employment. Instances have been known of splendid organizations suffering for years from the blighting effect of outside talent, that instead of improving conditions played havoc with the existing organizations.

Such cases as the foregoing, however, are, it is most gratifying to say the exception, and it is this exception which proves the rule, and by this standard it is safe to say that our railways and other allied interests today could illy afford to loose the very valuable service secured, either by direct employment, or through contractors and railway supply concerns who furnish without charge, regular assigned specialists in the fields to which their particular lines apply.

The specialist whose presence and activities have a blighting effect on an organization as a unit, and individually on each loyal efficient officer or employe who form an integral part thereof, is the one who approaches the problem on much the same ground as some detectives pretend to solve a crime, *i.e.*, by securing the arrest and indictment of someone who may be perfectly innocent of any wrong doing. The specialist or expert whose presence and activities are of incalculable value is the one, who as a basis, has a broad comprehensive knowledge of the problems to be solved, is of the highest order of honesty and integrity, and approaches the problems in the belief that the organization as a unit, and its integral members are good, and that his mission is to build up and strengthen, not criticise, find fault, and tear down; thus aiding all competent efficient loyal officers and employes in their duties, and thereby contributing to a more highly efficient organization as a whole.

The majority of railway officers, executive and administrative, are subject to such diversified and exacting demands on their time that many angles of the company's affairs for which they are responsible, do not receive that personal attention they would gladly devote if time permitted. It is in this and other related problems that the specialist or expert who can devote all his time, uninterrupted, to the problems in question, thus making it possible for the officer in charge to look at and clearly see the matter through the eyes of a neutral expert, who not being committed to any specific policy or practice, can render most valuable aid.

There are many manufacturers of railway equipment supplies and material whose dealings with the railways run up into many millions annually, who employ at a great expense to themselves, and furnish to the railways free, gratis, experts in their respective lines whose services are of great value. Among the more prominent or conspicuous may be mentioned (a) locomotive and car builders, (b) air brake manufacturers, (c) locomotive specialties, (d) lubricating experts, (e) fuel experts, (f) maintenance of way and signal specialties, etc.

The locomotive builders, it may safely be assumed, rank first in the combined volume of business and high grade expert engineering service rendered, while the air brake manufacturers with their large staff of highly trained experts distributed over the entire country render a service that the carriers could not duplicate and the money value of which would be difficult to estimate.

The next item in the order of its importance to railway operation would seem to be that of lubrication, as it is so closely interwoven with the interests of all concerned and on this account we might well use this subject for comparison and comment as to the relation between:

1. Lubrication, its cost and effect on other items of expense;
2. Maintenance of equipment as effected by lubrication;
3. Cost of fuel as influenced by lubrication

would seem to warrant these items being given special consideration in connection with the foregoing.

During the last year for which we have official reports (1920) the amount expended by the railways on the three items mentioned was as follows:

Items	Amount	Percent of total income
Maintenance of Equipment..	$1,612,356,385	25. 60%
Fuel for Locomotive........	689,632,039	10. 95%
Lubricants, grease, oils, etc. (est.)...................	33,200,00	00.053%
Total	$2,335,188,424	

From the foregoing it is quite clear that while of the three items totalling 37.36 per cent of gross earnings, lubricants is the smaller, yet to the student of railway problems it is well known that lubrication not only enters largely into the other major items, but to a greater or less degree *affect them*, and within certain limits may be responsible, therefore the companies who furnish lubricants for our railways and their representatives who have to do with their use, influence to a considerable extent the expenditure of: $2,335,188,424 out of a total of $5,886,573,383, or more than 37 per cent of total income, and almost 40 per cent of operating expenses, which is no small factor in the degree of economy obtained in the operation of our national transportation systems.

To those who may not have given this matter the attention it deserves, the foregoing is offered as a gentle reminder of the fact that, the manufacturers of railway equipment, supplies and material, have been for years and are now rendering valuable aid, through the medium of trained experts, to our railway officers in matters affecting the expenditure of many hundreds of millions of dollars.

Powerful Consolidation Type Locomotive

Lehigh & New England's New 2-8-0 Is the Heaviest of the Design Ever Constructed

The American Locomotive Company recently delivered to the Lehigh & New England Railroad four Consolidation type locomotives that are the heaviest and most powerful 2-8-0 type engines ever constructed.

The Consolidation type was a popular type of freight engine for a long period, but it has been largely superseded by the Mikado or 2-8-2 type locomotive in which the introduction of the trailing truck permits the use of a deeper firebox and longer boiler barrel with corresponding increase in boiler capacity. With equal weights on driving wheels and equal ratios of adhesion, a Mikado type locomotive will show no superiority over a Consolidation at starting; but as the speed increases, the tractive force of the Mikado will fall off less rapidly than that of the Consolidation, because of the greater boiler power of the 2-8-2 type.

The Consolidation, however, is still a very desirable type especially for heavy drag service where slow speeds will suffice, and where road clearances do not impose too many restrictions, by careful design a high capacity boiler may be obtained.

The following are the principal dimensions of these locomotives:

Gauge, 4 ft. 8½ ins. Cylinders 27 ins. x 32 ins. Valves, piston, 14 ins. diam. Service, freight.

Boiler—type, straight top, diameter 88 ins.; working pressure, 210 lbs.; fuel, soft coal.

Firebox—length, 126⅛ ins.; width, 96¼ ins.

Tubes—diameter 2 ins. and 5⅜ ins.; number, 301 and 50; length, 15 ft.

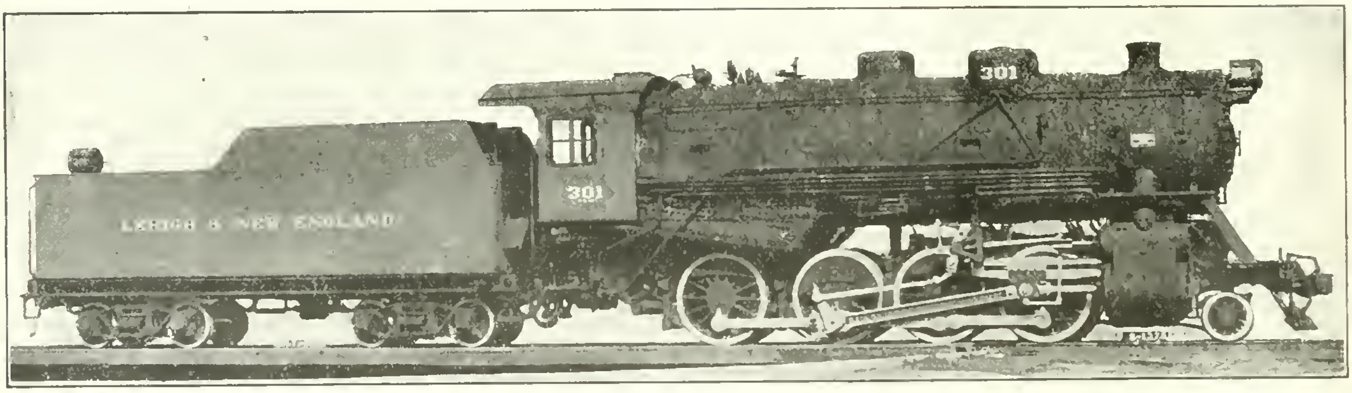
Grate Area—84.3 sq. ft.

Heating Surfaces—Tubes, 2,349 sq. ft.; flues, 1,046 sq. ft.; firebox, 233 sq. ft.; arch tubes, 38 sq. ft.; total, 3,666 sq. ft.; superheater, 901 sq. ft.

Driving Wheels—Diameter outside, 61 ins.

Wheel Bases—Driving, 17 ft. 6 ins.; total, 26 ft. 11 ins.; total engine and tender, 65 ft. 2 ins.

Weights in Working Order—On driving wheels, 279,000 lbs.; on front truck, 22,500 lbs.; total engine, 301,500 lbs.; total engine and tender, 485,600 lbs.



HEAVY CONSOLIDATION TYPE LOCOMOTIVE FOR THE LEHIGH & NEW ENGLAND RAILROAD.
(Built by American Locomotive Co.)

The bulk of the locomotive equipment on the Lehigh & New England is of the Consolidation type which is admirably suited to the conditions on this road, and in adding to its power it was decided to adhere to the same type, but to increase the capacity over that of the older locomotives with the result that in the locomotives under consideration we have an example of a well designed engine to meet special conditions.

These locomotives weigh 301,500 lbs., of which 279,000 lbs., is on the driving wheels. On page 164 of the June 1921 issue of RAILWAY AND LOCOMOTIVE ENGINEERING there appeared an article describing the Western Maryland 2-8-0 type engine which weighed 294,900 lbs., and which held the previous record for a locomotive of this type. This engine was built by the Baldwin Locomotive Works, and in connection with the article referred to there appeared a table which shows a comparison of the Western Maryland 2-8-0 with other heavy Consolidation types built by the Baldwin Locomotive Works.

The locomotives have cylinders 27 x 32 inches,—61-inch driving wheels,—carry a steam pressure of 210 lbs., with a rated tractive force of 68,200 lbs. The rated boiler capacity is 2,420 h.p. and the cylinder power 2,755 h.p.

Tender—Capacity, 10,000 U. S. gals. water; coal, 16 tons.

Traction power, 68,200 lbs.

Factor of Adhesion, 4.08.

Mixed Brakes

At a recent meeting of the Pittsburgh Air Brake Club, there was a discussion as to what effect the running of Empty and Load braked cars in trains with the standard type of freight equipment would have on the handling of a train. One of the members present, who had had considerable to do with the empty and load brakes mixed with standard brakes, stated that where they handled mixed trains of empty and load cars with standard equipment, that entirely satisfactory results were obtained. A series of road tests were conducted with 25 standard brakes on front of the train and ten Empty and Load brakes on rear of train (Brakes cut in Load position) and then reversing this combination, that is, 10 Empty and Load brakes on front of the train and 25 standard brakes on rear of the train, with the object in view of ascertaining the slack action in the train during brake applications, descending their mountain grades, and there was no noticeable slack action with either combination.

A New Measuring Stick for Locomotive Boiler Proportion

Graphical Analysis of Locomotive Boiler Proportions Reveals Science of the Thermic Syphon

By C. A. Seley

Consulting Engineer, Locomotive Firebox Company.

The designs of steam locomotives used in this country are of composite features, assembled from many sources, here and abroad. Experiments have been made with many failures and some successes. Due to the large interests involved and the general conservatism of railroad men, progress has been slow, although as a rule the locomotive has preceded track and terminal development by its size, weight and power and has kept the bridge designer busy.

The electric locomotive has produced an interesting competition, to say the least, and has set the mechanical people on their toes, so to speak, in an endeavor to so embody refinements and improvements in steam locomotive design, as will promote economies and efficiency; to be supplied not only in new designs, but also to existing equipment. Due to the abnormal conditions prevailing over most of the ten years past, the progress of locomotive betterment has been hampered, although some railroads have been able to work in more or less of a modernizing program on old power and some notable examples of new power have attracted attention.

Whether to consider old power or new, there should be a measuring stick by which to estimate the relative proportions of various classes and types of locomotives; although we now have various ratios, more or less empirical; informative it is true, and comparative with previous records, if one has taken pains to preserve them by any method of tabulation.

Boiler Relation to Cylinder Power and Fuel Rates Developed Graphically

In taking up certain work, it was found desirable to develop graphically locomotive boiler proportions in relation to cylinder power and fuel burning rates, and following is a description and explanation of a form of composite diagram that has been very satisfactory in showing at a glance the relative evaporative values of the contributing heating surfaces. It is based on the engineering methods and basic data proposed by Mr. F. J. Cole in designing boilers on horse-power basis.

There are certain fundamental facts to be rehearsed in order to make this diagram clear and adaptable to any location and the first is character of fuel, which varies so much. The remarks of Mr. Grafton Greenough at the last Atlantic City convention, explaining the reason why the Consolidation type locomotive is adaptable on certain railroads because of having fuel of high calorific value, are an interesting commentary. Not all coal is of 14,000 B. T. U. value and the lower grades are often complicated by undue proportions of ash and clinker forming characteristics. As coal of 14,000 B. T. U. value is taken as the basis of these calculations, the character of the fuel actually to be used should be taken into consideration in applying deductions from the diagrams as to heating surface performance and horse-power developed.

Another matter is the coal burning rate, which involves grate proportion. As compared with cylinder horsepower the boiler may be 100 per cent, but the performance will not be 100 per cent if the rate is, say, 180 lb. coal per sq. ft. of grate per hour as against 90 lb. It is said that a coal burning rate of 120 lb. is the maximum for economical evaporation, which is probably true for the majority of locomotive coals. The character of the service should be considered in this connection. Long sustained grades or long levels lend an opportunity for closer estimate of proportions than where choppy conditions are prevalent all over the railroad.

A Locomotive Is Only as Good as Its Boiler

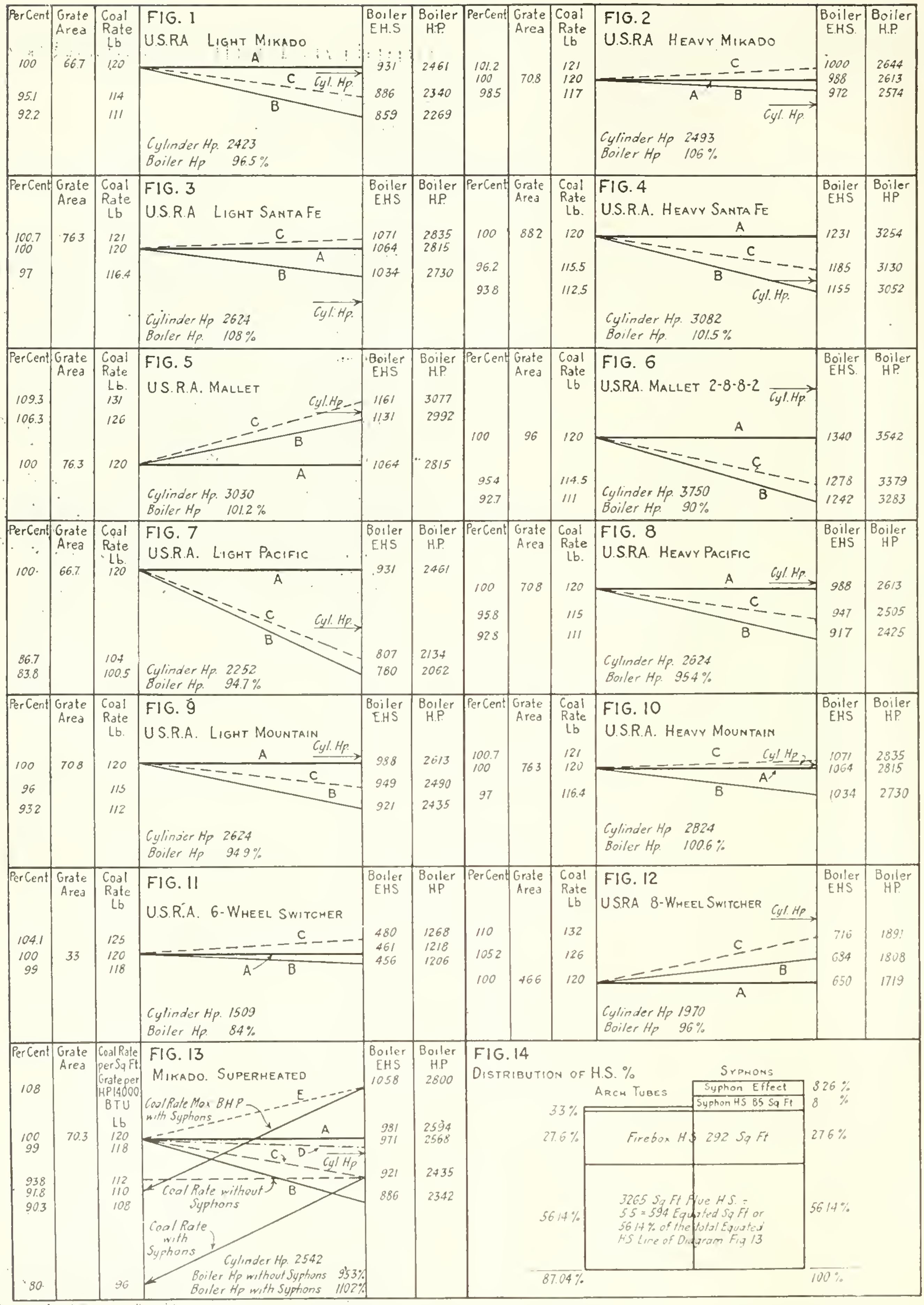
A boiler should have 100 per cent conditions of fuel, firing, cleanliness and tightness to insure its full quota of steam production. In fact, a locomotive is only as good as its boiler, generally speaking, and it has taken years to fully awake to this now evident fact.

The heating surfaces of a locomotive boiler are those of the firebox and flues, both generally estimated in square feet, although their relative evaporative value is approximately as six to one in the order named above. Roughly then, if we divide the flue heating surface by six and add the result to the firebox H. S., we have then an expression of the total equated heating surface in terms of a common rate of evaporation, which has been taken in these diagrams at 55 lb. water per sq. ft. of heating surface. Consideration is taken of the size, length and spacing of flues for obtaining a proper factor for equating to the common standard with the heating surface of firebox, combustion chamber, arch tubes, thermic syphons; all of which participate in absorbing the conducted and radiant heat of fuel combustion, while the flues are served by spent gases, extinguished in their entrance to the flues to a temperature below the point of ignition, which accounts for the lower evaporative rate of the flues.

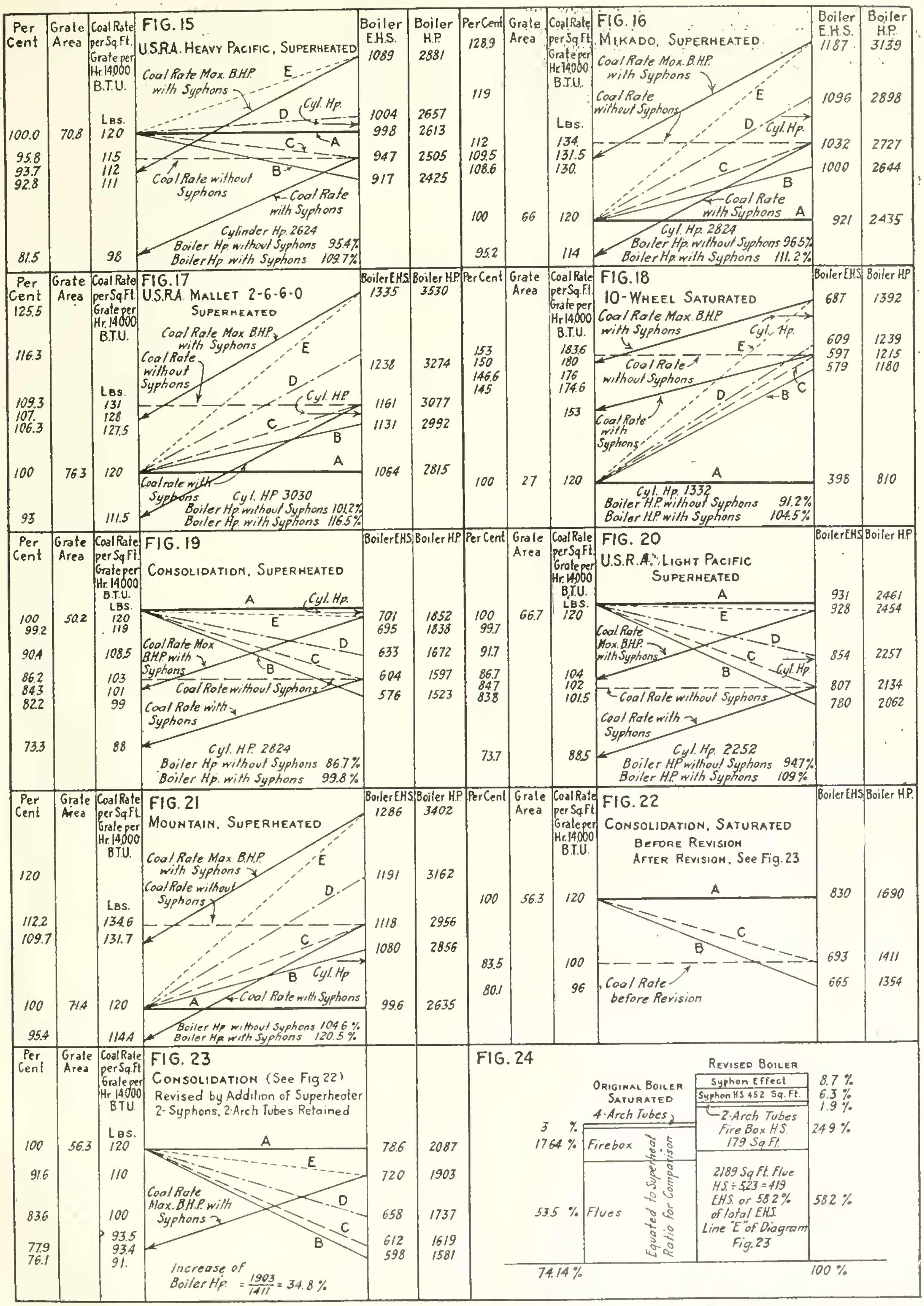
Water in the boiler being evaporated into steam has a potential value for work due to its temperature and pressure and this can be translated into horse-power, knowing the amount in pounds of steam per hour which will develop a horse-power of work. From the results of various tests, taken as authoritative, it has been found that if the steam is used directly as evaporated in a locomotive boiler, or slightly saturated, it will take 27 lb. per horsepower of work. If superheated as per usual locomotive practice, it will take 20.8 lb. and these figures are used in the boiler horse-power calculations in these diagrams. The total amount of water used per hour divided by the 55-lb. rate of evaporation per hour will give the total equated heating surface for a theoretical 100 per cent boiler, based on burning rate of 120 lb. coal per sq. ft. of grate per hour.

Standard Locomotive Designs Compared by Graphical Method

Assuming these calculations to be carried out, we now have data for the base or comparison line "A" of the diagrams; with columns at the left for writing in the coal rate (basic 120 lb.); the grate area of the boiler in question and percentages, line "A" being 100 per cent. At the right are columns for the equated heating surface and the boiler horse-power. On a predetermined scale, line "B" may be located, showing the equated heating surface and boiler horse-power of the locomotive in question, for the combined firebox, combustion chamber, if any, and



FIGURES 1 TO 12 INCLUSIVE ARE DIAGRAMS CONSTRUCTED TO ILLUSTRATE THE RELATIVE BOILER CAPACITIES IN RELATION TO CYLINDER HORSEPOWER AND THE RELATIVE GRATE CAPACITIES IN RELATION TO FUEL CONSUMPTION FOR U. S. R. A. STANDARD LOCOMOTIVE TYPES



FIGURES 13 TO 24 INCLUSIVE ARE DIAGRAMS DEVELOPED FROM DIMENSIONS OF A NUMBER OF LOCOMOTIVES OF VARIOUS TYPES TO ILLUSTRATE THE EFFECT OF APPLYING THERMIC SYPHONS UPON THE BOILER AND GRATE CAPACITIES OF THESE LOCOMOTIVES

flues. This may fall anywhere above or below line "A," depending on the equated heating surface proportions. Line "C" represents the addition of the heating surface of the arch tubes. In addition to the lines described, a short line and arrow point is used to indicate the cylinder horse-power on the boiler horse-power scale and below the percentages are written in. The percentages on the left are of the theoretical boiler line "A" and are used mainly in the computations.

Figures No. 1-12 are diagrams developed from the dimensions of some of the U. S. R. A. standard locomotives, affording a variety of information and possible accounting if taken in connection with value of fuel used for some characteristics. Undoubtedly, some features in these designs were brought about by the effort for standardization, there being seven sizes of grates for the twelve designs and six types, and in the case of the heavy Mountain and light 2-10-2 types, the boilers are identical, giving a very ample grate and low burning rate to the later design.

Of the freight types, the heavy Mikado and the light 2-10-2 types are very consistent examples of good design, reserve boiler horse-power and low burning rate to care for poor coal, and indifferent firing and boiler conditions. The heavy 2-10-2, while showing less per cent of reserve actually has it in lower burning rate.

The horse-power for the Mallets was not calculated, but approximated by that of simple engines of like tractive effort. The diagrams are interesting, as showing effect of relatively small grate to hearing surface, also coal rate, on the 2-6-6-2, as compared with the opposite conditions on the 2-8-8-2.

Of the passenger engine types, it will be noted that the light Pacific and light Mountain types have about the same boiler per cent to cylinder horse-power with somewhat of advantage to the Pacific, account of very ample grate and low burning rate for reserve, although the Mountain is not at all beyond the line of good proportions and very consistent with the heavy Pacific diagram. The heavy Mountain has somewhat more reserve and is practically at par with the 100 per cent theoretical line and with all conditions good, should make fine records in boiler performance

The switcher designs show what is considered good practice for boilers in short switching service in the 0-6-0 design and somewhat more liberal boiler proportions for the 0-8-0 for switching and transfer service.

Diagrams Show Effect of Syphon on Fuel Consumption and Boiler Capacity

The designs of the U. S. R. A. standard locomotives did not take into consideration use of thermic syphons, which were then in the development stage, but arches and arch tubes were used on all designs and all were superheated. The evaporative value of the arch tube heating surface, averaging about 30 sq. ft., is well shown. In the past fifteen years arches and arch tubes have by their merits become quite a standard fixture in locomotive fireboxes.

The use of thermic syphons as a means for enlarging the most effective heating surface of the boiler and for increasing water circulation to stimulate evaporation has, within the past four years, fulfilled their early promise of advantage in locomotive boiler operation, in capacity, economy and efficiency and are now generally recognized as a standard fixture of proven worth. Records of many road tests on a number of railroads, in all sections and classes of service show coal savings of syphon-equipped locomotives over non-syphon engines of the same class, but equipped with arches and arch tubes, per 1,000 ton-miles (adjusted), running from 12 to 25 per cent and over. Eliminating the high figures, the grand average is an 18 per cent coal saving; which, for a conservative figure that can be realized in regular service, has been further reduced to 15 per cent and diagrams Nos. 13 to 24 inclusive have been constructed to illustrate the effect of syphon application as follows:

The "A," "B" and "C" lines are for the same purposes as in previous diagrams, viz.: line "A" of theoretical 100 per cent boiler; line "B," firebox heating surface, including combustion chamber, if any, combined with equated heating surface of the flues; line "C," heating surface of arch tubes added; line "D," syphons substituted by deducting arch tube heating surface and adding syphon heating surface actually added to the firebox; line "E" is syphon effect derived as follows: If, instead of saving the coal, the extra amount is burned, and used to develop power, the additional horse-power and equivalent equated heating surface is as shown by line "E" and taken as a possible 100 per cent of boiler performance when equipped with syphons. Line "E" is 15 per cent added to the figures of line "C," the arch tube equipment performance. Heavy diagonal lines show coal rates with syphons indicating the pounds coal per sq. ft. of grate for the maximum boiler horse-power and also for the arch tube power with syphons, or by reading across, without syphons.

Figure 13 is of quite a typical design of a Mikado boiler having a capacity equal to 95.3 per cent of the cylinder horse-power, located by arrow-point above line "C," which line represents the maximum of boiler horse-power without syphons. Application of syphons with 85 sq. ft. of heating surface produces line "D" which is above the cylinder horse-power in actual heating surface and boiler horse-power, due to the standard rate of evaporation. Opposite this point is 99 per cent and 118 lb. coal rate, but the ground for a 15 per cent coal saving has already been laid, which would reduce the rate to about 100 lb. If, instead of saving this amount, it is burned, in order to obtain maximum boiler horse-power output, the result is shown by line "E," being 15 per cent added to line "C," the arch tube engine performance, giving also the total equivalent heating surface, or 100 per cent proportions. The coal rate for this amount of power, which may or may not be usable, is shown by the upper diagonal line at 110 lb. or 2.5 lb. less than the coal rate for the maximum boiler horse-power before syphons were applied, and for which power the syphons' coal rate, shown by lower diagonal line, is now 96 lb.

Thus, it will be seen that the diagram to and including line "D" is built on actual facts as derived from established engineering data, line "E" being an assumption on conservative lines of coal saving rate, brought about by an actual heating surface addition of about 8 per cent of the total equated heating surface and, also, the syphon effect on boiler water circulation and, further, the super-evaporative value of this device. Figure No. 14 illustrates the distribution of heating surface in percentage proportions, taking the total equated heating surface of Figure No. 13 as 100 per cent, showing a relation of 87.04 per cent for the boiler before syphons were applied to them.

A study of the U. S. R. A. standard locomotive designs shows that the heavy Pacific, light Mountain and light Mikado designs are in a class with the above as to relative boiler horse-power, grate and heating surface proportions and Figure No. 15 shows the result of syphon addition to the U. S. R. A. heavy Pacific design. The general characteristics of the diagrams are identical and in detail are proportional to the small differences in grate and heating surface proportions.

Effect of Limited Grate Area and Heating Surface Illustrated

Figure No. 16 illustrates the results of insufficient grate surface which means high coal burning rates and loss of economy and efficiency. It has been stated that 120-lb. coal rate is about the maximum amount for economical evaporation and in this diagram, reading across from line "C," the non-syphon arrangement shows 134 lb., a very high rate for continued heavy service. Addition of syphons with 95 sq. ft. of heating surface will provide ample reserve heating surface and bring the coal rate down into the economical field of combustion. The U. S. R. A. 2-6-6-2 design is in a similar class, with high coal rate for heavy service. The effect of applying syphons to these locomotives and the resulting coal rate reductions are shown in Figure No. 17.

There are many locomotives now in service having deep, narrow fireboxes of more extreme deficiency in area than the above examples, and with their high ratio of heating surface to grate, they may have weight and high cylinder horse-power much hampered by the small grate and excessive coal rate. It may seem foolish to add syphon heating surface in such a case, but diagram Figure No. 18 shows the case of a 27 sq. ft. grate calling for 180-lb. coal rate to develop 91 per cent of the cylinder horse-power, which by the addition of a syphon, provides boiler horse-power to balance the cylinder horse-power for maximum grades and lowers coal rates throughout the range of performance. Figure No. 19 illustrates an opposite characteristic of very ample grate and low burning rate, limited heating surface to supply the cylinder horse-power. In this diagram the total equated heating surface brings up the boiler to 99.8 per cent or practically at par with the 100 per cent theoretical boiler. The coal burning rates are now so low as to offer a chance of blocking off if found advisable for the quality of coal used.

The U. S. R. A. light Pacific and 2-8-8-2 Mallet designs are in a similar case to the above, and as shown by Figure No. 20 the application of syphons to the first named type, increases the boiler horse-power from 94.7 per cent to 109 per cent to care for inferior fuel, etc., and almost equal to the 100 per cent thearetical boiler proportions. The 2-8-8-2 Mallet can with syphon equipment show a diagram as to lines and proportions approximating the relatively high cylinder horse-power. Another condition of a moderate grate proportion with high proportion of heating surface to cylinder horse-power is shown in diagram Figure No. 21 of a Mountain type locomotive. There is reserve of heating surface for maximum boiler horse-power without syphons, but calling for a coal rate of nearly 135 lb., which syphon application would reduce to under 120 lb., and an additional margin in case of need. The Mountain type is rather a new development and this diagram makes an interesting study for comparison with the U. S. R. A. designs and others.

Tonnage Rating Increased 20 Per Cent by Superheater and Syphon Application

An increase of tonnage rating of 20 per cent sounds big, but is actually being accomplished in the revision of a series of Consolidation locomotives originally heavily built and capable of such an increase in tractive effort by cylinder and steam pressure changes. The original boiler had four arch tubes but no superheater and, as shown by Figure No. 21, was of 1,411 boiler horse-power. The boiler revision consisted of superheating, adding two syphons, retaining two arch tubes, the combined effect being to give an equivalent equated heating surface of 720 sq. ft. or 1,903 boiler horse-power, an increase of 35 per cent, with a very moderate coal rate, all as shown in Figure No. 22.

In Figure No. 23 is shown distribution in percentage of the heating surfaces and the effect of the revised design, as compared with the original dimensions equated to superheat ratio for comparison, or 74.14 per cent. The revised locomotive has successfully handled an increase of 20 per cent and over of the original engine tonnage rating, and, while this is an exceptional case, due to some of the features involved, no doubt, there are many locomotives that are capable of a similar line of treatment.

The foregoing diagrams prove for the syphon the ability to fit in for increased power, coupled with reduced coal rates, to meet any situation. The locomotive boiler is called upon to supply not only the cylinders with which its horse-power is generally compared, but also a lengthening list of auxiliaries, calling for steam in more or less quantity and for which definite provisions are not generally assigned.

Locomotive Most Complex and Compact of All Power Plants

It is quite true that locomotive service is not like that of a mill or a steamship having a constant load close to maximum. It is more like that of a power house where reserve units of production and fuel economizing may be adjusted to power demand and for equivalent horse-power to some of the locomotives diagrammed above, this power house would cover a fair fraction of a city block.

The locomotive boiler on the contrary must be self-contained and also adjustable to a complete range of power demand. By going to the heart of the matter, viz.: the locomotive firebox; reinforcing it in a very vital proportion of heating surface, together with the stimulation of water circulation throughout the entire boiler is the work and result of the thermic syphon, a device characterized in a paper contributed to the late convention of the International Railway Fuel Association with the statement that it "will probably be one of the standard fixtures in the locomotives of the future, as is the arch tube at the present time."

The Greatness of the American Transportation Plant

According to Mr. Donald Conn of the American Railway Association, the transportation plant of the country can be briefly described as follows:

There are 273,000 miles of steam railroads with a value of not less than $18,900,000,000, all privately owned and privately operated.

There are 44,250 miles of electric lines worth approximately $6,500,000,000, only some of which are privately owned.

There are 10,300,000 motor vehicles, of which 1,400,000 are trucks valued at approximately $8,750,000,000. For the use of these trucks more than $3,000,000,000 has been expended for good roads from 1910 to 1922.

There are 6,014 miles of inland waterways and rivers upon which the government has spent $155,119,000 since 1913 and 270 miles of inland canals costing $13,551,000 since 1913.

There is also the Panama Canal, costing $442,907,000, which has brought revenue in the form of tolls of $44,805,000 from the year 1915 to 1922.

In addition there are about 3,700 ocean going vessels of 13,465,000 gross tons weight.

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Our Thirty-sixth Year

With the coming of 1923 Railway and Locomotive Engineering begins its 36th year of continuous publication, and sends a greeting to one and all old friends and new and wishes them a happy new year.

It will be observed that with this issue we introduce in the reading pages the use of two columns to the page, with larger type for the more important subjects, with a corresponding increase in the number of pages.

From the first the chief purpose of the publication has been service. It aims to be a practical help to its readers in the dissemination of information to railway men in regard to the work in which they are engaged, and from the support and comments which we have received from our subscribers, coming from all parts of the world, it has in a large measure achieved this purpose.

Published for and in the interests of the mechanical department of the railways, Railway and Locomotive Engineering was early recognized an authority in its special field.

It has been a powerful force for the better education of railway men for the past 35 years, and we look forward to the years to come as a splendid field in which to continue to serve our readers here and abroad in as full a measure as we have in the past.

Railway and Locomotive Engineering starts her 36th year in a new dress, with new ideas and new courage, confident in the belief that in serving our readers to the best of our ability, guided by our experience and influence, we can also serve for those principles so paramount to railway men and railway interests in general as we project our plans for 1923, that justice and equity must obtain between employer and employee, and that our railways must receive more favorable consideration from all authoritative bodies and the public.

A Hungarian Passenger Locomotive

We have heard much and frequently of the impoverished condition of Hungary and Austria and the dilapidated condition of the rolling stock. But when it comes to the purchasing of new material it is very evident that what the officials consider to be the best is none too good. The Hungarian railways have long been noted for the novelty and boldness of their locomotive designs and the ten-wheeled machine illustrated and described in another column is a good example of this same spirit.

The two features that are especially noticeable on this locomotive are the Brotan watertube boiler and the feed water heater and purifier.

The Brotan boiler was first used in 1908 and attracted a good deal of attention at the time and was usually criticised unfavorably by engineers in this country who were familiar with its construction. It was hampered with a multiplicity of connections and with a drum at the top, which, being half filled with water made a heavy weight to be carried by the water tubes of the firebox and the three connections to the main boiler. The chief criticisms were aimed at this feature, on the ground that the stresses would be so great both from variations in expansion and the dynamic effects of the engine in motion, that it would be impossible to keep these joints tight in service. Whether these criticisms were justified by experience we do not know, but the design has been modified, ostensibly to avoid moisture in the steam, and the boiler so simplified that the earlier criticisms will not hold. The only point along those lines that remains is the connection of the water tubes.

Designers of watertube boilers in this country who have been working along similar lines have found that one of their principal troubles in service has been the holding of these tubes.

It is a rather unexpected development that the circulation in these watertube fireboxes is naturally poor. The old Yarrow and Thornycroft boilers, of the early English torpedo boats, gave a great deal of trouble in this respect and on some of the American designs a forced circulation had to be resorted to.

On these locomotives a large elbow is used for the delivery of water to the foundation ring, and it would be interesting to know whether this natural circulation is sufficient to maintain the same condition of flow and ratio of steam to water in the back tubes as is obtained at the front.

The coal saving cited is certainly a very noticeable feature, and it would be interesting to know the conditions under which this saving was effected.

Then, too, there is another point that is of vital importance to American engineers, and that is the rate of combustion used in these fireboxes. As a rule, this is much less on European than on American locomotives, and a firebox with tube connections that would very well sustain the expansion stresses with a rate of combustion of 100 lb. per. sq. ft. per hour, might fail under one of 140 lb. or more.

The results obtained with the feed water heater and purifier are certainly very remarkable and we know of nothing in this country that can parallel it. Data regarding the temperatures of the water as received and delivered are wanting, but to increase the period of washout from a run of 600 miles to one of 10,000 miles is certainly a noteable achievement, provided the raw water conditions are the same in both cases.

If these new locomotives built for a supposedly nearly bankrupt railway possessed no other features than these two they would merit close attention. Taken in connection with their setting they show that the Hungarian engineers are alive to the desirability of obtaining the maximum of economy in operation even though it may involve an increase of first cost.

Boiler Efficiency Makes for Economy

There is no branch or phase of railway engineering which has drawn so heavily upon, and been responded to so liberally by designing engineers as that of increasing the capacity and efficiency of the locomotive. Numerous methods, plans and devices have been developed by railway men, locomotive builders and professional engineers. Some have fallen by the way side, while others stand as enduring monuments to their inventors.

One of the inviting fields of effort for the inventive mind is in the matter of fuel economy, and this may well be so from the fact that the fuel bill for our railways last year was $689,632,032 or 11.58% of operating expenses, and during the past 22 years amounted to $5,365,067,941.00 or more than one quarter of the gross capitalizations of our railways.

Among the more recent devices is the Thermic Syphon for increasing the efficiency and capacity of locomotive boilers. The increased boiler capacity claimed, expressed in horse power being as much as 100, with fuel economy ranging from 10 to 25%.

Elsewhere in this issue, C. A. Seley has presented in detailed description and by graphic chart the merits of this device, and coming as it does from one of his extended experience and ability to handle intricate problems, it should receive careful consideration from those interested in increased boiler efficiency and reduced fuel bills.

Climbing the Ladder of Success

From the earliest history of man, there has always followed in the wake of wars and disturbances of the otherwise orderly activities of nations, state municipalities and communities of people, a period of unrest, crime, intemperance in all things, moral, physical and financial, and most destructive of all, almost complete disrespect if not disregard for, and in many instances open defiance of all constituted authority.

It is this character of mental intoxication usually born of the fruits of victory on the field of battle, in the marts of financial trade or industrial controversy, that has led nations, organizations and individuals into the commissions of the most egregious blunders, from the blighting effects of which, few recover and many suffer the full penalty.

Many striking examples might be cited, any of which would serve as a timely warning to those who, under the influence of misdirected leadership may be riding for a fall, when if they would right about face, and contribute an equal amount of energy in other directions they could accomplish wonderful results in the matter of increased efficiency individually and collectively.

Some of the greatest generals of all time have as the result of victories on the field of battle, become so intoxicated as to loose all sense of reason and fair play, and soon not only lost all fruits of victory but not infrequently their lives and impaired the happiness of their people. The same is true with many if not most of those who jump suddenly into prominence in the financial or social world, from the pinnacle of fame today they are soon conspicuous only by their absence.

By casting about it will be found that the solid reliable men of affairs in the marts of trade, finance, transportation and politics, are as a rule, men who from humble beginning, served long tedious self-sacrificing apprenticeship, taking the bitter with the sweet, always practicing thrift both at home and in business, always adaptable to changed conditions and with a wholesome respect for constituted authority, and it is the product of these conditions which furnish the men who are the bulwark of the nation. There is no human activity or class of men to whom the foregoing is more applicable than the great army of railway employes, and it is doubtful if there has ever been a time when a careful consideration of the fundamentals set forth would bring greater returns. Many profiteers, who blazed forth with a vulgar display of wealth suddenly acquired during the war have dropped from sight, some are in prison, others should by right be there, but most all who were possessed of ill-gotten gains and attempted to continue on the same scale after the war had ended, have either retrograded below their former level or are scheduled in that direction, while the corporation, family or individual, that practiced thrift, husbanding well the extra profits during the peak or floodtide of prosperity, can and already have, so adjusted their affairs to the changed conditions, that their *net* income is as great or relatively greater, and they continue to go up "*The Ladder of Success Rung by Rung*," unmindful of either the changed conditions, or the constant cries, threats and clamor of the professional agitator, who from the foot of the ladder shouts his insidious propaganda to those whom he seeks to lead astray, while he personally profits from their loss, failure or destruction.

There has probably never been a time in the history of civilized man and progressive industry, when the relations between individuals, corporations, and those in authority deserved the attention they do now and with positive assurance that he who does not act fair will be haled first before his superiors, and next to the bar of public opinion prompts all those who have to do with their fellow man to be extremely careful to administer justice in such measure that his acts will meet with the approval of all fair-minded disinterested men. In these circumstances the man with eyes fixed on the top of the ladder can well turn a deaf ear to, and disregard the plea, threat, or orders of those who through ignorance, misapprehension of facts, or any ulterior motive, may seek to sow the seeds of discontent among an army of employes who are enjoying far better conditions than was ever before known in the whole world.

There is only room for a few on the extreme top rung of the ladder, but on the intermediate rungs is ample room for that great multitude of live active American citizens, moving harmoniously both individually and in organized units, seeking information from many sources, but loyal to and serving first one master, on whose success their prosperity depends.

It can be safely said, without fear of successful contradiction, that there is not in the world today another body of men equal in number, standard and efficiency, or enjoying the favorable condition of service as the officers and employes of our railways, and through their adaptability to new and ever changing conditions the American people shall look forward to the uninterrupted service of our great transportation systems, for he who contributes to the welfare of his country, his community, his family and himself, is without doubt *Climbing the Ladder of Success.*

Running Wild

"What has become of the tin locomotive and train of cars I gave you on your birthday?"

"All smashed up," replied the small boy. "We've been playing government ownership."—*Washington Star.*

A Letter to the Editor on the Stability of Locomotives

Brighton, England.

To the Editor:

I have received a copy of your article on the stability of locomotives which appeared in your publication of November, 1922.

This publication interested me very greatly and I feel that I should like to give some slight expression of opinion in support of the experiments which I carried out some little time back.

The experiments were undertaken in the first place to ascertain various data concerning different designs of bogies and their resultant effect on the oscillation of a locomotive travelling at high speeds. It was only incidentally that the question of "symmetrical" types was raised (a term which I fail to understand without further qualification).

Unfortunately, I am not conversant with the American investigations which you quote, as to exactly how these were carried out, and I am therefore at a disadvantage in making a comparison of the methods adopted and the results obtained. But, as far as I am able to gather from your article, the American investigator measured the lateral blow delivered by the engine as a whole on the rails, this leading me to assume that the stability of the locomotive was considered from the intensity of the impact laterally, and not from the actual vibration which took place due to this impact. If this is so, it would seem to me that a comparison between these investigations and those carried out by myself, which are actual measurements of the various locomotives tested, is not quite practicable as the variables due to locomotive design and conditions of track have to be taken into account.

I quite agree that the intensity of the impact between the wheel and the rail depends to a certain extent on the condition of the track which, naturally, has a resultant effect on the oscillation of the locomotive. The point raised concerning the construction of the track I feel can bear but little on the question as, for any comparison to be made, it must be assumed the tracks in all cases were in good condition; therefore the "galloping" or "nosing," almost entirely due to crippled joints, will not arise.

Care having been taken with the designing of the bogies to ensure lateral control adequate to carry out their initial function of guiding the mass, thereby relieving the flange pressure on the coupled wheels, and with proper location of centrifugal forces, etc., it has been found by my tests that the vibrations of the so-called symmetrical 4-6-4 locomotives are less than those of any of the other types tested.

The analogy you use of the blow of a hammer on two springs, is an exceedingly happy one if applied to the tests carried out by myself, but with the converse result.

The diagrams show the extent of compression of the lateral springs in inches, and, in the case of swing links, the amount of deviation from the centre. These are known quantities and can be definitely stated in lbs. side thrust, with the result that, when the side thrust curve is applied to the diagram, the symmetrical engine shows a maximum lateral thrust considerably under the maximum of the unsymmetrical types, with a resultant beneficial effect on the track.

We now come to a closer definition of this word "symmetrical." Personally, I am somewhat at a loss to understand in what way the term "symmetrical" is intended to be applied. Surely it is not the intention to use this term in a geometric sense, as, if so, presuming a trailing truck was placed under one of your "Consolidation" engines 2-8-0 which had sufficient over-hang to accommodate it, your engine would immediately become unstable due to the fact that it would then be symmetrical. I cannot seriously believe that it is intended to convey the idea that the geometrical arrangement of the wheelbase has any serious effect on the stability of the engine any more than the colour of the paint has any such far-reaching effect.

There is only one other sense in which we can apply this term and that is the dynamic sense. Here we have I think the true meaning, and one of considerable importance, which would materially affect the stability of the locomotive.

For the engine to be symmetrical dynamically, would necessitate the longitudinal centre of gravity being placed directly over the driving wheels in a 4-6-4 type, presuming the wheel arrangement to be absolutely goemetrical, and the play given between wheels and rails, axles and boxes, boxes and guides, would also have to be symmetrical about the centre. Any material departure from the combination of these effects would at once destroy actual harmony of movement, and would therefore tend to increase stability.

In the symmetrical engine under test, the centre of gravity was some considerable distance away from the driving wheels. This fact alone would have the desired effect of destroying any harmony, and would bring about a considerable difference in the dynamic forces exerted at the leading and trailing bogies.

I am somewhat under the impression from the limited knowledge I have of American practice that, in many cases, trucks and bogies are controlled by single top pin swing hangers arranged vertically or inclined, or heart-shaped hangers with double top pins. In the vertical type the controlling power is quite negligible, this being somewhat improved by the inclination of the hangers, but it is then practically all exerted by one side; and this arrangement of control is still further improved by adopting the heart-shaped or double top pin hangers. None of these arrangements however compares favorably with control springs, especially in relation to the initial movement from the centre which is of the greatest importance in order to prevent "nosing" or swinging at high speeds, and it is in this direction that we must look for unsatisfactory running.

Presuming a test were made on a locomotive, either symmetrical or unsymmetrical, without, or with a deficiency of, lateral control, I can quite understand that the results arrived at would not be satisfactory, and it would be quite possible for it to be claimed that the symmetrical locomotive gave even worse results than the unsymmetrical. But this effect could not be ascribed to the fact that the locomotive was symmetrical but that your engine had a tremendous over-hang at both leading and trailing ends uncontrolled and would, naturally, swing violently about the centre.

To illustrate this, take a type common in England, 0-6-0, which by your definition is unsymmetrical, although it is in fact symmetrical geometrically. This type is steady, and holds the road well. Extend the over-hang of leading and trailing ends say, five or six feet. Would you say this unsymmetrical engine was very stable? Would you be prepared to travel at 60 miles per hour on her?

I must crave your indulgence in writing at such length, but this question is one that has interested me for some time, and I should be only too prepared to alter the opinions I have formed if convincing proof were put before me. In the meantime, the best proof is the steady riding and quick recovery over crossings at speed of the

4-6-4 type engine, which qualities are observable enough in comparison with other types without diagrams.

If at any time some of the American engineers who are interested in this question are over here, I shall be delighted to give them the opportunity of riding on the footplate of a so-called symmetrical express engine with complete confidence that they will live to see America again.

L. B. Billinton, Loco. Engineer,
London, Brighton & South Coast Railway.

Referring to the letter from Col. L. B. Billinton on this subject, which comes to us in reply to an editorial comment on the published reports of his investigations that appeared in Railway & Locomotive Engineering for November, 1922. The letter brings up a number of points that call for a little further elucidation; the first of which is that of the "symmetrical" engine. In the editorial in question, the results referred to were those of engines having a "symmetrical wheel base" and not having a symmetrical disposition of the weight as Col. Billinton seems to have understood it. On this basis a consolidation (2-8-0) locomotive is unsymmetrical but it becomes truly symmetrical when it is converted into a Mikado (2-8-2).

In our editorial we attempted to harmonize the apparently conflicting conclusions of the American and English observers, and in spite of claims made for the "steadiness" of the latter's locomotives.

As we stated before, the two observers approached the subject from opposite standpoints. Col. Billinton measured the oscillation or vibration of the engine and the American observer measured the lateral thrust of the wheel against the rail. Col. Billinton claims great steadiness of motion for the 0-6-0 engines, which, by the way, falls within our definition of a symmetrical wheel base. But the action of this engine in taking a curve is found by the American observer to be exceptionally severe on the track, not so much, in this case, perhaps, because of the symmetry of the wheel base, as because it has no leading truck. The same statement holds for a consolidation (2-8-0) locomotive when running backward. As to what the effect of these two engines so running, are upon a tangent track there is no data available. But, we submit that it might be possible for them to run steadily and yet put enough intensity into their vibration to exert a very considerable thrust upon the track. It was also found that the condition of the lateral play in the driving boxes affected the stress put upon the rail; but not, perhaps, to the extent that might be expected.

The methods used by the American observers prevented them from so analyzing their results as to be able to determine which wheels put the maximum and minimum stresses on the rails, so that it might be quite possible for wheels at the centre, where the oscillation was least to have exerted the maximum stress. That this is so is proven by an investigation into the action of an electrical locomotive on a tangent track, where the thrust of each individual wheel was measured. In this engine which was of the 4-8-4 type, it was found that the third driver or fifth wheel was the one delivering the maximum blow, in spite of the fact that the maximum oscillation occurred at the ends of the machine.

It is, perhaps, not quite fair to draw an inference as to what an engine will do on a straight track from what it does on curve, but a statement of fact may not be out of place. Take consolidation (2-8-0) and Pacific (4-6-2) locomotives and numbering their wheels from front to back, it was found that, on the consolidations, the maximum blow was delivered by the first pairs of wheels followed in order by 3, 5, 4, 2 at low speeds and by 3, 2, 4, 5 at high speeds. In the case of the Pacifics; again the first pair of wheels delivered the maximum blows, followed by 4, 5, 6, 3, 2 for all speeds. From which it appears that the trailing wheel of a Pacific (4-6-2) locomotive exerts a strong pressure on the track due to the guiding effect which it is called upon to exert.

The American investigations did not touch upon the oscillations or vibrations of the locomotive and Col. Billinton confined himself to them. It is not probable that they will be found to be antagonistic or inconsistent if only someone can be found to tie them together.

Ed.

I. C. C. Says Rail Earnings Inadequate

In the annual report of the Interstate Commerce Commission, which has just been published, the Commission says, regarding railroad rates and earnings:

"In our last annual report we also directed attention to the favorable tendencies in railroad net earnings shown for the later months in 1921, following the unfavorable condition prevailing at the opening of that year and during the preceding year. The net railway operating income for the entire calendar year 1921, as shown in Table A of Appendix C to this report, was $614,810,531, clearly an inadequate income. The analysis of this result, made early in 1922 in our consideration of Reduced Rates, 1922, supra, disclosed that the lower basis of operating costs then prevailing had not been effective during the entire year of 1921, and the reports of tonnage moving and in prospect indicated that the traffic of 1922 would be substantially in excess of that of 1921.

"Our expectation that earnings would be on a basis of sufficient magnitude to permit of reduction in the level of freight charges led to the adoption of our report in Reduced Rates, 1922.

"The reduced rates and charges prescribed became effective on July 1. The tonnage moved by the railroads has been steadily increasing in recent months until, at the end of the period covered by this report, the traffic is almost equal to the largest ever handled by our railroads. Manifestly the existing rates are no longer interfering with the free flow of commerce as a whole, whatever may have been the situation prior to the reductions of July, 1922. Little opportunity has been afforded for determination of the effect of the reduced rate level upon the net earnings of the carriers because of freight congestion and other abnormal conditions, which have resulted from the coal strike, the shopmen's strike, and other causes, elsewhere discussed."

Regarding the movement of traffic within the past year, the Commission submitted the following data on loadings, which shows that in October the railroads of the country moved nearly 50 per cent more traffic than in January of this year, and about 15 per cent more coal:

1922.	Coal.	Total, exclusive of coal.	Total, all commodities.
January	703,001	2,357,166	3,060,167
February	760,504	2,314,460	3,074,964
March	885,055	2,838,157	3,723,212
April	302,211	2,728,979	3,031,190
May	362,567	3,084,379	3,446,946
June	414,853	3,350,911	3,765,764
July	327,763	3,260,361	3,588,124
August	443,244	3,486,917	3,930,161
September	738,885	3,311,981	4,050,868
October	845,629	3,455,858	4,301,487

The Railway Freight Car

What It Does in the World's Transportation

By W. E. Symons

Consulting Engineer

Every dollar earned by a railway company for transportation is earned by a locomotive as it is obvious that cars laden with passengers, freight, express, mail, etc., can only store, house, or otherwise protect their contents, and that a prime mover is necessary to produce transportation or revenue. It therefore follows that while the locomotive moves everything that is transported, other integral parts of the complete transportation unit play an important part in, and are entitled to much consideration, when making a division of credit to the different factors involved.

The Freight Car

As the freight car plays a most important part in the transportation systems of the world, it might not be amiss to cast up in tabulated form for comparison, some of the more essential features and functions.

Freight Statistics of Seventeen Different Countries.								
Country	Number, Capacity, Tons, Carried, Aver. Rev. per Car, Rates, etc.							
	Number *	Capacity in Tons	Tons Carried	Freight Revenue	Average Earning Per Car*	Rate Per Ton Mile	Average Miles Haul	Year
United States	2,380,036	41.5	2,305,190,000	$4,373,989,717.00	$2,042.00	1.064	181	1920
England	789,735	8.0	317,877,500	591,886,974.00	845.00	3.28	25	1920
Germany	692,000	14.11	618,351,054	526,743,807.00	845.00	1.37	62	1913
France	370,000	8.0	208,018,895	206,023,920.00	619.00	1.28	77	1913
Canada	209,243	34.3	101,303,989	163,663,744.00	870.00	1.07	251	1920
India	196,747	25.0	87,650,000	152,655,840.00	862.00	.74	232	1920
Austria	146,842		163,812,174	162,061,707.00	1,143.00	1.51	65	1913
Italy	103,117	15.8	37,145,897	63,721,393.00	686.00	0.93		1915
Belgium	85,615		66,011,442	39,016,968.00	513.00	1.13	52	1912
Sweden	26,558	12.6	15,132,937	53,735,072.00	2,244.00	4.119	56	1919
Australia	52,008		16,754,089	47,110,536.00	1,007.00	3.80	80	1920
Japan	48,568	10.6	33,313,720	54,417,625.00	1,245.00	.92	105	1920
N.S. Wales & New Zeal.	43,220	8.7	19,010,443	47,545,810.00	1,225.00	2.10	107	1920
Norway	24,028		6,103,000	17,197,292.00	795.00	5.56	51	1920
Brazil	25,869		9,778,322	56,353,206.00	2,420.00	7.67	75	1915
Switzerland	21,207	13.11	18,097,793	29,778,214.00	1,564.00	5.57	45	1919
China	10,748	23.0	18,551,684	44,490,537.00	4,588.00	0.79	114	1918
Totals & Averages	4,327,749		4,022,172,949	$6,630,772,362.00	$1,532.00	2.528	92.2	
* Less 10% in shop								

TABLE 1. GIVING DETAILS OF THE PART THE FREIGHT CAR PLAYS IN THE WORLD'S TRANSPORTATION

From the foregoing tabulation a rather clear and comprehensive idea may be formed of the relative conditions in freight transportation in widely separated parts of the world. The freight revenue or income and average amount per car, the rate per ton mile, and distance or length of haul, all are of course, governing factors.

In the design, construction, operation and maintenance of a complete transportation unit, safety to life and property is one of the prime considerations, while with passenger equipment the personal convenience and comfort of the traveler must be considered, particularly in competitive territory.

With the prime mover or locomotive it is simply a question of suitability and economy, and therefore a railway engineering proposition for disposition of the carriers' officers.

With the freight equipment, however, other features enter and must be recognized. The shipper must have in many cases available cars suitable to move his product to market at a given time or suffer loss if not financial ruin, while other commodities are less seasonal, and may be handled in cars not of special design.

Certain commodities essential to the life of a nation, which either due to lack of storage space at point of consumption or to their perishable character must be transported as used, should be assured prompt movement without interruption, and any person or persons who conspire to prevent this should be considered a public enemy and be dealt with accordingly.

Classification of Freight Cars

The revenue freight cars of the United States are divided in seven different classes as follows:

Box Cars	1,053,593
Flat Cars	112,982
Stock Cars	81,727
Coal Cars	953,932
Tank Cars	12,997
Caboose Cars	59,782
Other Freight Cars	105,023
Total	2,380,036

Table No. 1 contains much food for thought in the matter of car capacity, average length of haul, rate per ton mile, and the average earnings per freight car per year. In reaching the latter figure an allowance of 10 per cent is made for cars out of service for repairs or other causes.

If statistics furnished are correct and calculations accurate, it appears that the Chinese are getting a greater return per freight car per year than any of the seventeen countries shown, although their rate per ton mile is with one exception the lowest. Their average haul of 114 miles while above all other countries except three is less than the United States by 67 miles, but in spite of this their average earnings per freight car is $4,588 against $2,042 in the United States which, if correct, would indicate that the Chinese are able to keep their cars more constantly moving, thus earning revenue, except for the actual time necessary for loading and unloading.

U. S. Leads in High Grade Equipment

There is no question among those qualified to speak, as to the United States being leaders in the invention, design, construction and operation of the highest standards of railway equipment in the world, although in some operating features our managements have not been able to attain the high mark of efficiency reached by others, for reasons beyond their control.

There is no country in the world where the same exacting requirements of equipment and service have to be met as in the Unitel States. One or two examples will serve to make this point clear. The melon and fruit crops from Florida and California valued at millions of dollars must be moved once each year promptly when ripe, otherwise they are a loss. For this traffic a high-grade expensive car is required. The California traffic is almost wholly in refrigerator cars that jumped from pre-war prices of $1,200.00 to $1,500.00 up to and above $4,000.00 during the war and are yet away above former figures, and while there is a seasonal scarcity of this kind of equipment, in the long hauls of 1,000 to 3,000 miles there then follows the dull period when thousands of these cars are standing idle. The same is to a greater or less degree true with respect to coal, stock, and even box cars for the heavy grain movement, so that when one considers the diversified character of traffic with seasonal features, the disposition of shippers to use cars for warehouse purposes and the attitude of numerous regulatory bodies, who seldom aid in lightening the carrier's burdens, it may be said that the results are better than might be expected.

The freight car equipment has not been given that place of importance in the estimation of many railroad men that it justly deserves, true there are some exceptions but as a rule the freight car both in matters of first cost, suitability for service and facilities for repairs has not received the attention given to locomotives and passenger equipment.

False Economy in Buying

There is probably no feature of the railroad business so delusive as the true definition of economy, as it is constantly given widely different and often contradictory meaning. When used in connection with drawing specifications for, or in actually buying material, finished parts or complete units it is usually intended to mean the purchase price, as: I specified or bought certain things cheaper than so and so's quotation and thereby saved the company so many thousands of dollars.

There are many railway officers that have saved millions of dollars for their companies through good judgment in specifications or buying, while there are others who actually thought they were saving large sums, when as a matter of fact in the last analysis the company will pay the top price with numerous penalties added. There is no other integral part of the transportation unit where this will, on investigation, be found so evident as in the matter of freight cars, and no clearly defined explanation as yet has been made for this seeming inconsistency.

For many years freight cars, except certain series of special design have been practically thrown into a pool as it were and interchanged for use and movement over all lines in the United States, Canada and Mexico, while locomotive and passenger cars are kept on the owning company's rails, and while this fact does not directly affect purchasing price of material or parts, it does materially affect the quantity on hand owing to the wide range of design, and this feature may at times influence price or quality of material for use on foreign cars.

Again, freight cars being purchased in much larger quantities than locomotives or passenger cars, sometimes results in the designer or purchaser being led into an erroneous conclusion as to real sure-enough economy, and what has actually at times been capitalized as a wonderfully shrewd business deal involving a saving of great sums of money, has turned out to be a most egregrious and expensive blunder.

As an illustration, if in the design or purchase of five locomotives or passenger cars a theoretic saving could be shown of say $300 to $500 per unit by using certain specialties claimed to be *just as good*, but which on careful analysis were alike in name only, and not at all comparable as to function or capacity and might affect the real value or efficiency of the complete unit, there would be no hesitancy in declining to use the cheaper device and thus insure a strictly high-grade, first-class unit unit throughout. But when we come to the freight car the very same men's mental apparatus seems to work in just the reverse direction. We will assume three thousand cars are to be purchased and that the theoretic saving in purchase price by the use of something *just as good* is $100 per car instead of $300 to $500 or an item of $300,000 in financing the new equipment. It is safe to say that in the majority of cases the same men who so jealously guarded the company's interest and their own reputations as designing engineers and shrewd railway officers, will turn a back hand spring, to capitalize the theoretic saving of $300,000 and then what happens say during the next ten years. These cars cost in various ways about ten actual extra dollars for each theoretic dollar lopped off the purchase price or about $3,000.000 which is charged to operating expenses and lost sight of, and seldom ever considered as having any relation to original cost of the equipment, and to this must be added the loss of use of a comparatively new car for repairs, usually out of service when most needed in a rush period, and finally the car men are blamed for failures primarily due to errors in design or purchase, and rough treatment in operation.

The greater the individual corporation or nation, the greater potential possibility for great achievement or error, and it therefore behooves all those who have to do with design, purchase, operation or maintenance of equipment on our railways, especially freight cars, to guard well against errors of omission or commission, which at first blush sometimes appear to have all the earmarks of economy and sound business judgment, yet in the last analysis may prove just the reverse.

The Power Brake Hearing

The adjourned hearing on Power Brakes before the Interstate Commerce Commission was renewed in Washington on December 4, and continued to a final adjournment on December 8, 1922. At this session the railroads, under the chairmanship of C. E. Chambers, superintendent of motive power of the Central R. R. of New Jersey, presented their case and cross-examined some of the witnesses of the air brake companies. At the adjournment February 10, 1923, was set as the date for the filing of the briefs of the interested parties.

Railway Shop Kinks

Some Special Devices Used for Testing and Maintaining Air Brake Equipment

Brake Cylinder Packing Leather Testing Rack

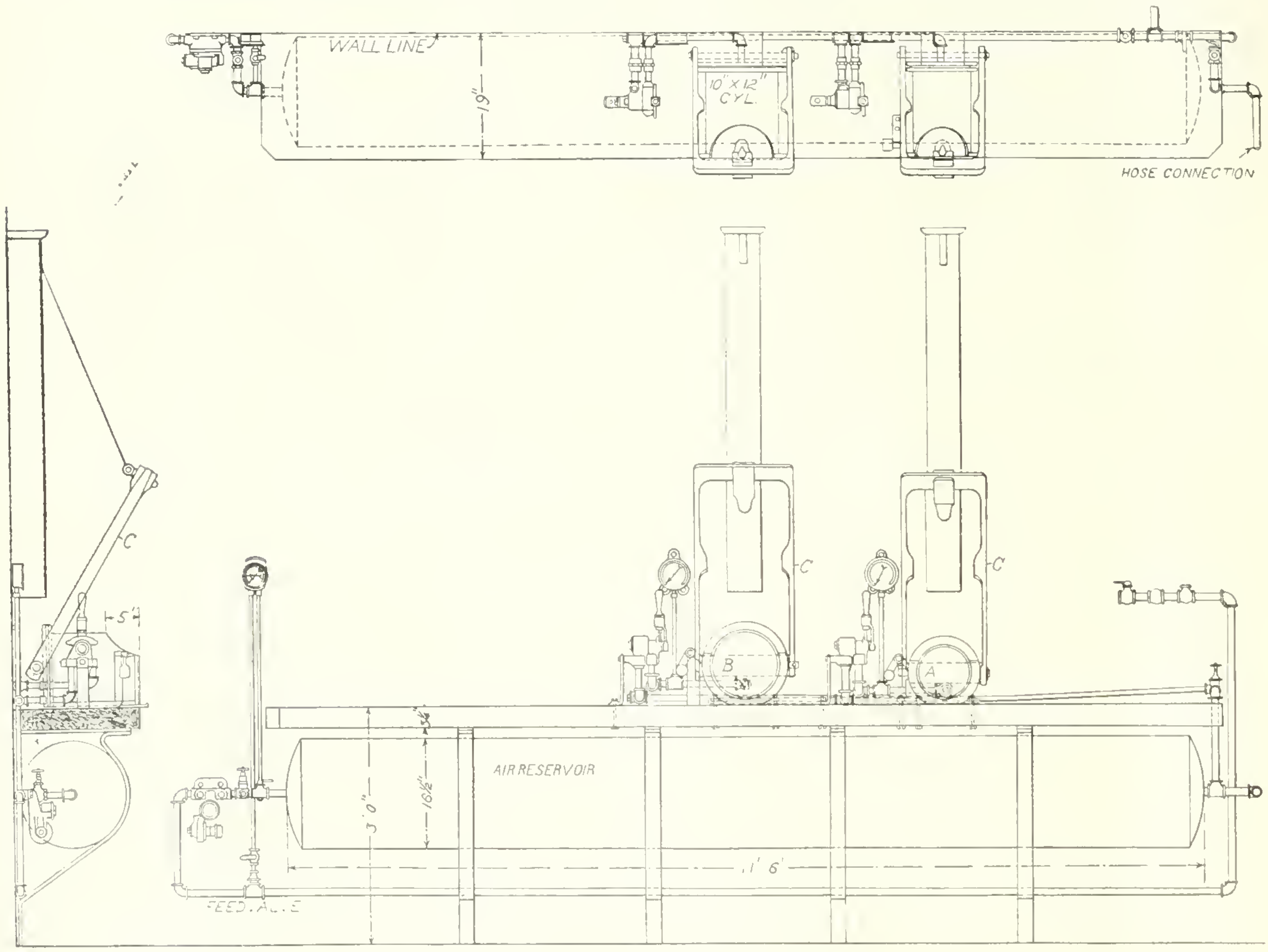
On one of our more important railway systems there are a number of special devices in use for the maintenance, inspection and repairing of the air brake mechanism.

There is a rack used for the purpose of testing brake cylinder packing leathers for tightness. The essential working parts consist of two cylinders *A* and *B* of 8-inch and 10-inch diameter respectively each having a length of 12 inches. In addition to these there is a yoke *C* that is used for holding the piston in place against the testing pressure in the cylinder.

There is a table raised 3 feet above the floor and to this the two cylinders are set horizontally. Beneath there is an air reservoir 16½ inches in diameter and 12 feet long with a capacity of 27,050 cubic inches. This is larger than is absolutely necessary as it is permissible to use one of 18,000 cubic inches.

This reservoir is charged with air from the main air pipe in which there is a stop cock. The air is fed to this reservoir through a feed valve which is adjusted to 55 lbs. There is a two-handed air gauge, as shown, one hand or tube being connected to the main air pipe and the other to the pipe leading to the reservoir so that it always indicates the pressure existing therein.

From the opposite end of the reservoir a pipe leads up and back of the two cylinders, to which air is admitted to them through the back heads by a lever valve, a pressure gauge being placed between it and the cylinder. The back, or pressure head, is ground to a tight joint instead of a gasket being used for the purpose; and to the outside of it there is bolted a crossbar having trunnions at its ends on which the yoke *C* turns.



BRAKE CYLINDER PACKING LEATHER TESTING RACK

At the front end the cylinders are cut away as shown to facilitate the insertion of the piston with the packing that is to be tested. The end is cut away 2½ inches on its diameter for the 8-inch cylinder and 3½ inches for the 10-inch and then back for 5 inches on a curve. This makes it possible to enter the packing at the face and push it back into the gradually increasing periphery of the cylinder until it is fully entered. It is then pushed back as far as need be to permit the yoke to be drawn down so that it stands in line with the center line of the cylinder. Its sides are ground back so that they just clear the nonpressure end, and it is held in place by a lock which swings down to allow it to pass and then comes up into place under the action of the weight at the end of the bell crank of which it is formed.

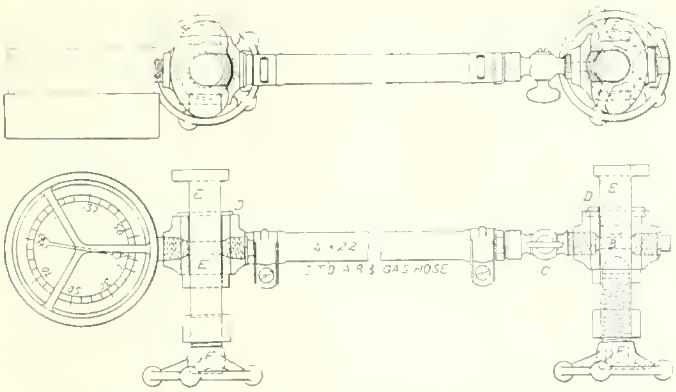
The weight of the yoke is counterbalanced by a weight rising and falling in a tube in which it is hung, as shown by a ⅛-inch wire cable.

With the piston in place, air is admitted to the back end of the cylinder, until the reservoir pressure of 55 lbs. per sq. inch has been reached. It is then shut off and the guage at the cylinder indicates the rate of leakage.

When the test is over the valve is opened, the air exhausted to the atmosphere the piston and its rod is pushed back to give a clearance for the lifting of the yoke. The piston can then be quickly removed and another inserted, so that the work can be done with great rapidity.

Brake Cylinder and Retaining Valve Test Device Arrangement

Then there is the device here shown for testing on brake cylinders and retaining valves for leakage. There is a small pressure gauge whose stem is screwed into a connecting casting *A*. This is connected to a second similar casting *B* by a piece of ¼-inch standard air and gas hose 22 inches long. Between the hose and the casting *B* there is a ¼-inch stop cock *C* by which the free communication between the two can be closed.



BRAKE CYLINDER AND RETAINING VALVE TEST DEVICE ARRANGEMENT

These castings are fitted with a rubber seat *D*, made by the Westinghouse Air Brake Co. by which a connection is made to the brake cylinder and the retaining valve. There is a yoke *E* having a side opening, as shown in the plan. This yoke straddles the main casting and carries the handwheel *F* with its attached screw, which has a hemispherical bearing in the casting as shown in the *B* casting.

The pipe leading to the retaining valve is uncoupled and the side opening in the yoke of the casting *A* is slipped over the pipe to the brake cylinder and the yoke drawn back by turning the handwheel *F* until the seat *D* is drawn against the union. The same is done with the yoke on *B* to the section of pipe running to the retaining valve.

The stop cock is then closed and an application made. The fall of pressure as indicated by the gauge will show the rate of leakage of the cylinder packing. Then, after another application and opening the stop cock the rate of retaining valve leakage can be determined by substracting the first rate from the second.

Owing to the rough usage to which this apparatus may be subjected, there is a standing rule that the gauge should be inspected once each week.

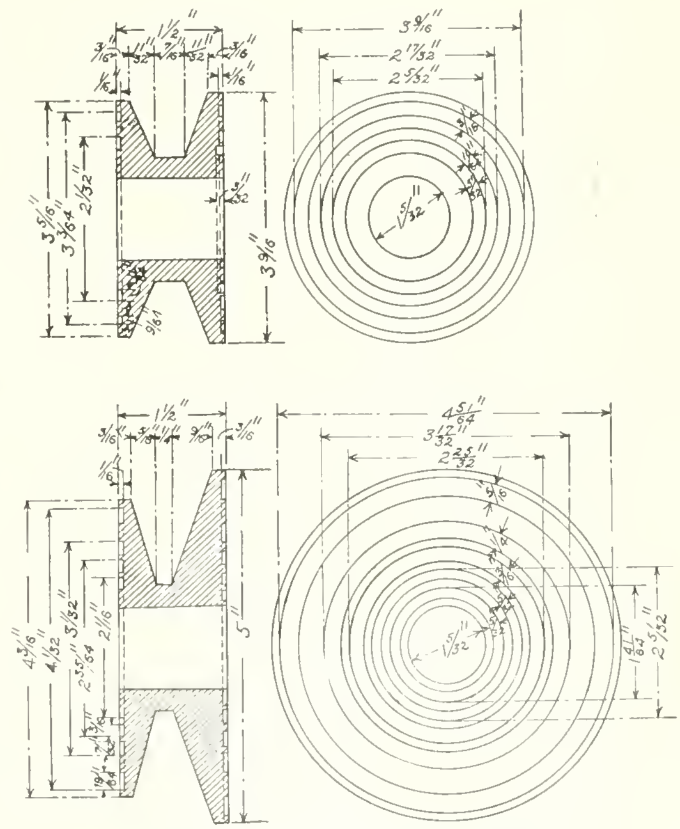
Holder for Lapping Piston Rings

The holders here shown will serve for lapping or grinding the piston rings of air compressors, governors, steam heat regulators and the valves of air brake equipment. They are circular in form with a V groove cut in their periphery to give a convenient means of grasping with the hand.

Coupled with the holder it is necessary to have a grinding plate. A convenient size for such a plate would be 12 inches by 9 inches by 1¾ inches. One surface of it should be ground flat and a sheet of No. 00 emery cloth cemented to it; care being taken that all air bubbles and lumps should be removed.

The piston rings are to placed in a groove of the proper diameter in the holder and rubbed on the emery covered surface until they are worked down to the thickness desired.

The grooves cut in the face must have a clean right angle between the sides and bottom or the rings will not set down into them properly and hold. The series of



HOLDER FOR LAPPING PISTON RINGS

grooves in the two holders are 1/16 inch deep and vary in outside diameter from 4 51/64 inches down to 1 41/64 inches, so that about all the air brake piston rings that need this kind of treatment can be handled.

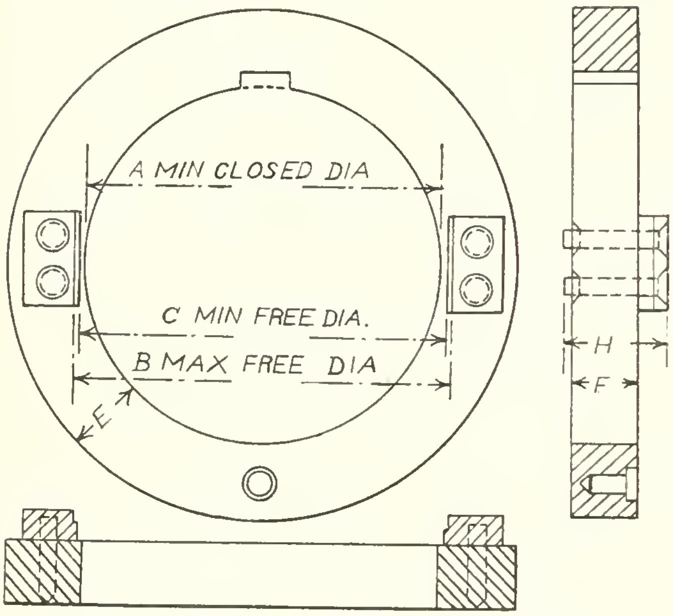
Gauges for Brake Cylinder Leather Expanders

The gauges whose dimensions are given in the accompanying table are intended for the inspection of brake cylinder leather expenders in order to insure that they are in condition to exert a proper expanding force against the leather in holding it out against the cylinder walls.

The body is a simple ring of the thickness *F* with gauging lugs fastened to one face diametrically opposite each other.

The rule for using the gauge is that, when the expander is placed in the gauge ring at *A* its ends should not be less than 1/32 inch nor more than ¾ inch apart, and its outside should not stand away from the inner surface of the same more than 1/32 inch at any point.

The ends of the expanders are then to be placed opposite the notch in the gauge, and resting first between the dimension *B C* and then between the dimension *B*. When placed between the lugs of dimensions *C* its free diameter must fill the full space, and, when between dimension *B* it must not fill the full space. These two



GAUGES FOR BRAKE CYLINDER LEATHER EXPANDERS

Cyl. Dia. Ins.	A	B	C	E	F	H
6	5 5/8	5 7/8	5 13/16	1 3/16	1	1 11/16
8	7 5/8	8	7 29/32	1 3/16	1	1 11/16
10	9 5/8	10 1/8	10	1 5/16	1 1/8	1 13/16
12	11 5/8	12 1/16	11 15/16	1 5/16	1 1/8	1 13/16
14	13 5/8	14 5/16	14 3/16	1 3/8	1 1/8	1 13/16
16	15 5/8	16 5/16	16 1/8	1 1/2	1 1/8	1 13/16
18	17 5/8	18 7/16	18 1/4	1 7/8	1 3/8	2 1/16

TABLE OF DIMENSIONS FOR BRAKE CYLINDER LEATHER EXPANDER GAUGES

dimensions thus form limit gauges for the free outside diameter of the gauge.

Special instructions are issued prohibiting the use of the gauges as an anvil or former for truing up defective expanders.

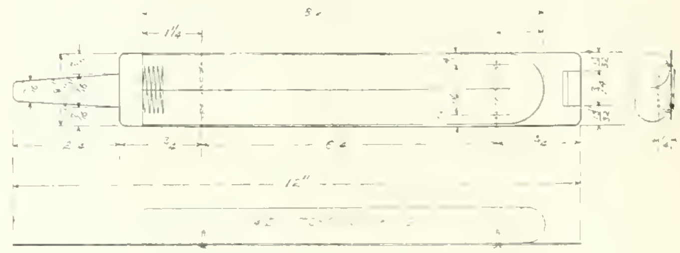
Swab for Air Pump Piston Rod

A piece of felt or wicking wrapped about the piston rod of the air pump is the form of swab usually encountered and its shortcomings from the standpoint of efficient lubrication are many. The swab here shown is a substantial structure and one that will cling to the rod as long as there is any elasticity left in its fibers.

It is shown straightened out as it is made and not as it is used.

The plate or backing is made of No. 25 gauge tin and is cut to the shape shown in the upper engraving or plan. It is of rectangular shape with a projection of the shape of a file tang at one end and a slot, measuring ⅛ inch by ¾ inch, punched in the other. A length of ¾-inch diameter torch wicking is bent double, with its ends sewed together, and is then fastened to the plate at the two points with No. 15 gauge annealed wire. The method of stitching the wicking of the end elevation from which it will be seen that the wire does not come anywhere near the surface of the wicking.

For use the swab is wrapped around the rod, with the wicking against it, and the tang put through the slot and turned back to hold it. In that way the wicking is held firmly against the rod until its elasticity is entirely gone.



DETAILS OF AIR PUMP PISTON ROD SWAB

A swab made to the dimensions given is suitable for both the 9½-inch pump and the 8½-inch cross compound compressor; one being required for the former and three for the latter.

Three New Railway Lines in Central and South Africa

If railway projects in Central and South Africa are carried out, the Belgian Kongo, Rhodesia, and Central South Africa will be connected within the next five or six years with the Atlantic Coast by three new railways, opening up vast tracts of undeveloped territory hitherto untouched by civilization, and shortening the distance between the ocean and existing gold and copper mines.

The proposed railways include the connection of the Katanga and Kasia districts of the Belgian Kongo with the mouth of the Kongo River, the completion of the Benguela Railway, and the construction of a new line between Walvis Bay and Mafeking.

The Belgian government proposes to begin the Kasia Railway early next year and complete it by 1929. This railway will run from the present railhead of the Cape-to-Cairo line to a point 30 kilometers south of the confluence of the Kasti and Sankura Rivers, where a deep water port has been located. Traffic will be carried along this railway and the Kasai River to Kinshasa, where there is now a railway to Matadi, and from there a river route to the mouth of the Kongo is available.

The Benguela Railway will provide a direct route from the Katanga Copper field to Lobito Bay, 1,160 miles. A third of it has been built and it will be completed as soon as capital can be secured. The completion of this line will greatly shorten the ocean transportation of Katanga copper, which now has to be carried out through Portuguese East Africa.

The Walvis Bay line will not only serve Southwest Africa, but Southern Rhodesia and the Transvaal. Part of this line has been constructed. When it is completed to Mafeking it will reduce the transportation of freight by 1,000 miles, shorten the distance between the United States and Europe to the Transvaal by three days and three nights, and provide for the disposal of surplus cattle in Southern Rhodesia and South West Africa. The government of South Africa has appropriated £600,000 for harbor works at Walvis Bay and it is understood that a large freezing works is contemplated.

Automatic Train Control From a Mechanical Standpoint

By C. F. Giles

Superintendent of Machinery, Louisville & Nashville Railway

A paper presented before the Western Society of Engineers, October 23, 1922

The general requirements of an automatic train stop or train control device as prescribed by the Interstate Commerce Commission are three-fold—

First: It shall be effective when the signal admitting the train to the block indicates stop and, so far as possible, when that signal fails to indicate existing danger conditions.

Second: An automatic train control or speed control device shall be effective when the train is not being properly controlled by the engineman.

Third: An automatic train stop, train control or speed control device shall be operative at braking distance from the stop signal location if signals are not over-lapped, or at the stop signal location if an adequate over-lap is provided.

It is not the intention of the author of this paper to treat with, or even express an opinion on the merits or demerits of any device having for its purpose the automatic control of train operations, or the practicability of so doing, preferring to leave these questions to be settled between the inventors and the carriers, but rather to attempt to show what the adoption and operation of such a device really means to the Mechanical Department of the carriers.

In order to accomplish the results to be obtained, viz., that of controlling the speed of, or bringing a train to a full stop with any kind of a device operating in connection with or without wayside signals, be it mechanical trip, electrical contact, or ramp type, or electrical induction type of track elements, each and every locomotive operating regularly or occasionally in track equipped territory would necessarily have to be equipped with a device, or devices, that will, at the proper moment, should the engineman fail to observe a caution or stop signal or be running at an excessive rate of speed, cause the air brake to automatically act in the service or emergency application according to the demands of the exigency and at no other time.

Such devices must necessarily, by reason of the important and complicated character of service which they are required to perform, be of complex design and delicate construction, as may be readily observed by an examination of the cuts and descriptive matter issued by the inventors.

Neither will I attempt to enter into details with respect to the mechanical features of the numerous devices that are being tested, developed and offered to meet the requirements. Suffice it to say the conclusions reached by the Joint Committee on Automatic Train Control, appointed for the purpose of investigating automatic train control devices, from a practical standpoint, establish the fact that all devices of the kind in question, some of which are now in limited use on a few of the carriers' lines, are still in the experimental or development stage, and that numerous objectionable mechanical and other features remain to be solved and corrected before the automatic train control apparatus may be considered as thoroughly practicable, reliable and suitable for railroad requirements. Then again, tests are now being conducted of certain types of automatic train control devices which the designers claim will operate under more ideal conditions than the types of devices which have been in use to a limited extent on some of the lines. As a result of the above conclusions, it cannot be definitely stated at the present writing just what type or types of automatic train control will probably be selected by the railroads as being the most desirable in all respects for general installation, and, therefore, my views and remarks on the subject under discussion are necessarily predicated largely upon conception.

Aside from the expense of the initial application of an automatic train control device to a locomotive, proper and adequate maintenance will undoubtedly prove the most vital and perhaps difficult factor to contend with from a mechanical standpoint. The modern locomotive, representing such a large capital investment, must necessarily be handled and placed in serviceable condition at terminals with all possible dispatch so as to minimize the unproductive period of time during which this investment remains idle. It goes without saying that every additional device applied to a locomotive requires a certain amount of care and attention, more or less proportionate to the intricacy of the mechanism, intensity of use or importance of function—all tending to retard the prompt completion of the work of inspection and repairs to locomotives at terminals. Therefore, unless such devices effect economies at least commensurate with the time and labor expended for their proper maintenance, prove a burden and distinct loss from a financial standpoint.

The only device on a locomotive today to which the maintenance and inspection of the automatic train control may be considered as being comparable is the automatic air brake equipment. In this connection, it appears opportune to briefly ponder the extent and scope of the educational plans and organization of forces that proved necessary to insure the successful maintenance and operation of the automatic air brake when adopted many years ago. This consisted of training and educating the shop foremen and a considerable number of mechanics, and the assignment of special forces to maintain the inspection and repairs of such equipment; and of educating the enginemen and trainmen so as to familiarize them with the proper methods of operating and the functioning of the various parts. To accomplish this it was necessary for practically all carriers to fully equip air brake instruction cars with a complete set of air brake apparatus, so mounted as to clearly demonstrate the actual operation of the various devices in road service, and appoint competent instructors to accompany the cars to all points on the road that lectures of a practical and educational nature could be delivered to the attending classes of employes.

The methods for instructing and training the employes as outlined above must also be regularly and constantly carried on to effect satisfactory results in the operation of the equipment by the enginemen upon whom devolve the making of emergency repairs, with the least possible delay, to defects developing on the line-of-road and to insure proper inspection and repairs to the apparatus on the part of the shop and engine house mechanics specially tensive in their scope, will have to be inaugurated to suc- assigned to this work. It appears only reasonable to predict that somewhat similar methods, more or less ex- cessfully care for the inspection and maintenance of the automatic train control apparatus when applied to locomotives. However, the insurance of the successful operation of the latter device will quite probably prove more difficult of attainment than the air brake, for the reason that no occasion may arise for the automatic train control to function during one or many complete trips and consequently no reports from the enginemen concerning its operative condition can be anticipated; whereas, the condition of the air brake equipment, which is regularly operated on every trip, can and must be intelligently reported on by the engineman after arrival at terminals. While the engineman's report itself is not considered as sufficient to be relied upon without also extending the ordinary engine house inspection and attention, nevertheless, such reports are of considerable value to the repair and inspection forces in assisting them to more promptly locate and rectify defects responsible for the unsatisfactory operation of the air brake; or should the brakes not be reported as requiring repairs or attention it renders unnecessary any extensive tests of the apparatus to insure its effectiveness.

Thus, in the case of locomotives equipped with the automatic train control device, it is quite apparent that a complete and extensive test of the latter must necessarily be conducted on arrival at, and before departure from each terminal to determine whether or not it will satisfactorily and unfailingly perform the important automatic function that may be required of it on the following trip and to locate and repair any defects that may exist in the equipment. The extent of the maintenance required will, in a measure, depend on the nature of the particular installation, the number of locomotives equipped, the type of device selected and the extent of train control that is desired. Nevertheless it is obvious that additional forces of expert employes will have to be assigned to properly maintain this important and intricate mechanism, in addition to keeping accurate and infallible records of its condition that such records may be produced whenever required for any cause. The additional work of repairs and inspection demanded of the equipment will tend to materially increase the time required for the completion of repairs to locomotives held at engine terminals for that purpose. Upon due consideration of the foregoing, it is not an exaggeration to say, nor is it difficult to conceive, that the adoption of the automatic train control device will impose a heavy burden and responsibility upon the mechanical departments to say nothing about the other departments in this respect.

The Great Indian Peninsula's New Articulated Car

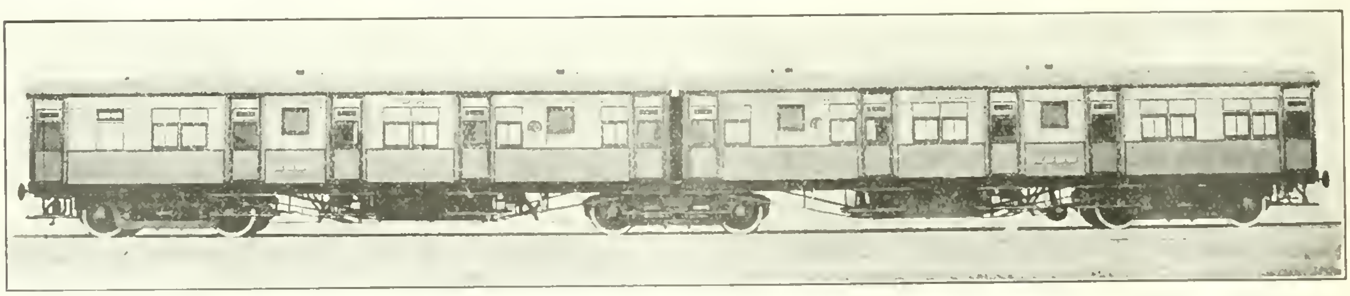
By Our India Correspondent

Since the introduction of the bogie truck under passenger cars used for all through express trains, a problem often presents itself in the travelling season, particularly on mail days in Bombay, etc., to provide accommodation for one or two extra passengers without having to attach a full bogie truck car, which vehicle may have to make a return journey empty of 1,400 miles; the season travel in India being generally all in one direction. A "four-wheeler" sandwiched into a rake of bogie cars is not favored, and if attached outside the rear van, the traveling is none of the best. To meet this condition, the Great Indian Peninsula Railway with commendable enterprise have introduced a "twin" articulated car which provides the accommodation required, whilst retaining the bogie principle for the full formation of any train it may be incorporated in.

This method of introducing a bogie truck between two car bodies has been largely adopted on the Great Northern Railway in England as also on one or two Continental railways. The first named have as many as 5 car bodies running on 6 bogies with a corresponding reduction in dead weight, first cost, running friction &c. The G. I. P. Ry. example has been built at the Matunga shops and meets as stated above, a very important requirement. The bogie trucks are of the so-called Pullman type in which the truck frames are supported by equalizing beams resting on the axle boxes; the wheels are steel disc of Taylor Bros., Manchester, England, manufacture.

The bodies are of G. I. P. Ry. standard construction, Burma teak being used for the framing, steel plate for the panels and various fancy woods, etc., for the internal finish. Insulation is secured by a layer of Uacolite, asbestos composition, between the inner and outer linings of the car bodies.

The underframe is built of steel channel and sections of Indian manufacture and it has a compensating buffer gear arranged to operate with the drawbar. Electric lights and fans are provided and to equalize the load over the framing as much as possible, the dynamo is carried adjacent to one of the outer trucks, whilst the cells, (Edison's) are arranged for in close proximity to the other; this tends to equalize the load over all the bogies. The two adjacent coupés at the center of the coach can be put into communication to form one, or the dividing doors can be shut to make two private coupés.



NEW ARTICULATED CAR ON THE GREAT INDIAN PENINSULA RAILWAY

We may add that the traveling of this car is remarkably smooth, the oscillation being more or less limited by the fact that the center of the middle bogie takes the two inner ends of the half bodies and holds them as it were, steady. The easy running of the Great Northern trains built on this system in England has often been commented on, and there is no doubt this arrangement of making the different cars of a train form one articulated unit has much to do with steady running. The introduction of this system into India by the G. I. P. Ry. will be watched with considerable interest by all railwaymen.

Stress and Strain in Car Wheel Iron

The Bureau of Standards in Washington has recently made an investigation into the stresses and strains that can be developed in car wheel iron. For the purpose of the investigation three wheels were selected, each made by a different manufacturer and each was subjected to identical tests. These consisted in straining the metal up to an elongation of .006 in. per inch of length in sixty increments of .0001 in. each and noting the stress required to produce this strain for each increment.

Strain in Inch	Stress in Pounds Per Sq. In.							
	Actual Stress				Per .0001 in. Increment of Strain			
	Wheels				Wheels			
	A	B	C	Average	A	B	C	Average
.0001	1,950	2,000	2,000	1,983	1,950	2,000	2,000	1,983
.0002	3,600	3,400	3,600	3,533	1,650	1,400	1,600	1,550
.0003	5,000	4,800	5,400	5,066	1,400	1,400	1,800	1,533
.0004	8,900	6,000	7,100	6,666	1,900	1,200	1,700	1,600
.0005	8,400	7,000	8,800	8,066	1,500	1,000	1,700	1,400
.0006	9,600	7,600	10,200	9,133	1,200	600	1,400	1,067
.0007	10,700	8,600	11,600	10,300	1,100	1,000	1,400	1,167
.0008	11,800	9,000	12,900	11,233	1,100	400	1,300	933
.0009	12,600	9,600	14,000	12,066	800	600	1,100	833
.0010	13,300	10,300	15,000	12,866	700	700	1,000	800
.0011	13,900	10,600	15,700	13,400	600	300	700	534
.0012	14,500	11,000	16,400	13,966	600	400	700	566
.0013	16,000	11,500	17,000	14,500	500	500	600	534
.0014	15,400	11,950	17,800	14,983	400	450	600	483
.0016	16,900	12,200	18,300	15,466	500	250	700	483
.0016	16,300	12,600	18,900	15,933	400	400	600	467
.0017	16,700	12,900	19,400	16,333	400	300	500	400
.0018	17,200	13,200	20,000	16,800	500	300	600	467
.0019	17,600	13,500	20,400	17,166	400	300	400	366
.0020	18,000	13,800	20,700	17,500	400	300	300	334
.0021	18,300	14,000	21,000	17,766	300	200	300	266
.0022	18,600	14,400	21,400	18,133	300	400	400	367
.0023	19,000	14,600	21,600	18,400	400	200	200	267
.0024	19,200	14,800	21,900	18,633	200	200	300	233
.0025	19,500	15,000	22,100	18,866	300	200	200	233
.0026	19,800	15,300	22,400	19,166	300	300	300	300
.0027	20,100	15,500	22,600	19,400	300	200	200	234
.0028	20,400	15,700	22,900	19,666	300	200	300	266
.0029	20,600	15,800	23,200	19,866	200	100	300	200
.0030	20,900	16,000	23,400	20,100	300	200	200	234
.0031	21,200	16,200	23,500	20,300	300	200	100	200
.0032	21,400	16,400	23,700	20,500	200	200	200	200
.0033	21,600	16,500	23,900	20,666	200	100	200	166
.0034	21,800	16,700	24,100	20,866	200	200	200	200
.0035	22,000	16,800	24,200	21,000	200	100	100	134
.0036	22,200	17,000	24,300	21,166	200	200	100	166
.0037	22,500	17,100	24,500	21,366	300	100	200	200
.0038	22,700	17,300	24,700	21,566	200	200	200	200
.0039	22,900	17,400	24,800	21,700	200	100	100	134
.0040	23,100	17,600	24,900	21,866	200	200	100	166
.0041	23,300	17,700	25,000	22,000	200	100	100	134
.0042	23,400	17,800	25,200	22,133	100	100	200	133
.0043	23,600	17,900	25,400	22,300	200	100	200	167
.0044	23,800	18,000	25,500	22,433	200	100	100	133
.0045	24,000	18,100	25,600	22,566	200	100	100	133
.0046	24,100	18,200	25,800	22,700	100	100	200	134
.0047	24,300	18,300	25,900	22,833	200	100	100	133
.0048	24,500	18,400	26,000	22,966	200	100	100	133
.0049	24,700	18,500	26,100	23,100	200	100	100	134
.0050	24,800	18,600	26,200	23,200	100	100	100	100
.0051	25,000	18,600	26,300	23,300	200	000	100	100
.0052	25,200	18,650	26,400	23,416	200	50	100	116
.0053	26,400	18,700	26,500	23,533	200	50	100	117
.0054	25,600	18,800	26,700	23,700	200	100	200	167
.0055	25,800	18,900	26,800	23,833	200	100	100	133
.0066	25,900	19,000	26,900	23,933	100	100	100	100
.0057	26,100	19,100	27,000	24,066	200	100	100	133
.0058	26,500	19,200	27,100	24,266	400	100	100	200
.0069	26,500	19,300	27,200	24,333	000	100	100	67
.0060	26,700	19,400	27,300	24,466	200	100	100	133

TABULATION OF STRESS STRAIN INVESTIGATION OF CAR WHEEL IRON

The strains were carried to a point that nearly reached the breaking point of the material in each case.

The specimens were cut from cast iron car wheels and were not from specially poured samples.

It will be noted that the stress of wheels *A* and *C* are about the same while that of wheel *B* is only about two-thirds of the value of the other two.

The fall in the increment of stress as the strains is increased is also very marked, dropping from an average of 1,983 lbs. for a train of .0001 in. per inch of length between zero and a strain of .0001 in. to 133 lbs. for the same increment of strain between .0059 in. and .0060 in.

It is probable that the limit of elasticity was reached immediately after the first extension of .0001 in. had been reached. For that increment the modulus is 19,830,000, from which it drops off very markedly at once, as the strain is increased and falls to a little more than 4,000,000 for the final total.

This investigation is valuable and interesting in that it is a very complete study of the stress and strain manifestations of car wheel iron, and throws some light on the peculiarities that have been observed in the cracking of plates under the influence of heating by the brake-shoes.

For example; in the tests of the Bureau of Statistics wheels were broken with a differential of temperature of less than 300° Fahr. between the rim and the plates, while at the University of Illinois a differential of 500° failed to cause a fracture.

If the coefficient of expansion is taken as .0000556 per one degree Fahr. and the mean diameter of the rim is assumed to be 31 in., then with a difference of 300° between the temperature of the rim and the plate there would be a strain of about .026 in. set up which would have to be distributed through a space of from 4 in. to 6 in. and so might well set up a stress to crack a weak wheel like that marked *B*, and so may be regarded as a valuable contribution to information regarding this class of equipment.

A. S. M. E. Code of Ethics

Adoption of a code of ethics, governing its membership of approxifately 20,000, is announced by the American Society of Mechanical Engineers. Ultimately, it is expected, this code, prepared by a joint committee of the national engineering societies, will apply to the entire engineering profession, embracing more than 200,000 professional engineers.

The mechanical engineers are the first to adopt the code, according to the chairman of the joint committee, Prof. A. G. Christie of Johns Hopkins University. This action, Prof. Christie stated, marks an advance in engineering ideals, and, in respect to the government of its members as a whole, places the profession in a position analogous to the professions of law and medicine. The code commands loyalty to country, personal honor, fairness to contractors and workers, and interest in the public welfare. Betrayal of professional confidences, undignified or misleading advertising, and questionable professional associations and practices are prohibited.

The text of the code, as given out in New York City by John L. Harrington of Kansas City, new president of the American Society of Mechanical Engineers, follows:

"Engineering work has become an increasingly important factor in the progress of civilization and in the welfare of the community. The Engineering Profession is held responsible for the planning, construction and operation of such work and is entitled to the position and authority which will enable it to discharge this responsibility and to render effective service to humanity.

"That the dignity of their chosen profession may be maintained, it is the duty of all engineers to conduct themselves according to the principles of the following Code of Ethics:

"1. The Engineer will carry on his professional work in a spirit of fairness to employees and contractors, fidelity to clients and employers, loyalty to his country and devotion to high ideals of courtesy and personal honor.

"2. He will refrain from associating himself with or allowing the use of his name by an enterprise of questionable character.

"3. He will advertise only in a dignified manner being careful to avoid misleading statements.

"4. He will regard as confidential any information obtained by him as to the business affairs and technical methods or processes of a client or employer.

"5. He will inform a client or employer of any business connections, interest or affiliations which might influence his judgment or impair the disinterested quality of his services.

"6. He will refrain from using any improper or questionable methods of soliciting professional work and will decline to pay or to accept commissions for securing such work.

"7. He will accept compensation, financial or otherwise, for a particular service, from one source only, except with the full knowledge and consent of all interested parties.

"8. He will not use unfair means to win professional advancement or to injure the chances of another engineer to secure and hold employment.

"9. He will co-operate in upbuilding the Engineering Profession by exchanging general information and experience with his fellow engineers and students of engineering and also by contributing to work of engineering societies, schools of applied science and the technical press.

"10. He will interest himself in the public welfare in behalf of which he will be ready to apply his special knowledge, skill and training for the use and benefit of mankind."

Annual Meeting of the A. S. M. E.

The forty-third annual meeting of the American Society of Mechanical Engineers was held in New York, December 4 to 7, inclusive and was noteworthy in many respects.

There were twenty-four sessions, fifty-three committee meetings and four social events. The number of members registered was 1836.

Among the many valuable papers presented and the discussions which they brought out, it is impossible for us to more than refer to a few of them briefly.

The address of the retiring president, Dexter S. Kimball on "National Leadership"; the address of Dr. Wesley C. Mitchell on "Making Good and Making Money," and that of Mr. E. M. Herr, President of the Westinghouse Electric & Manufacturing Company on the "Human Problem in Industry," were masterpieces and should be read by everyone interested in business progress, engineering achievement or the welfare of mankind.

The report of Mr. Calvin W. Rice, secretary of the Society on his South American trip was of special interest to all those who appreciate the importance of closer relationship between our sister republics and the engineering societies. Doubtless, Mr. Rice's trip will have accomplished much in this direction.

Mr. John Lyle Harrington of Kansas City, Mo., president for 1923 was inducted into office with the usual ceremony, and judging by the business-like manner with which he took hold of the Society's affairs, it can safely trust to his leadership. Mr. Harrington remarks on the economic question should be heeded by all who wish to aid in solving the industrial problems.

The paper by Mr. Howard E. Coffin on Commercial Aviation in America not only contains excellent suggestions as to legislative action and financial aid, but facts and information with respect to this industry, surprising to some and useful to all.

The Railroad Session

The Railroad Session of December 6, was presided over by James Partington of the American Locomotive Company, at which three papers were read; Steam Distribution in Locomotives, by G. H. Hartman; Mechanical Draft for Locomotives, by F. H. C. Coppus; and Stresses in Locomotive Frames, by R. Eksergian.

Mr. Hartman's paper was discussed at considerable length by Messrs. O. W. Young, Engineer, Pyle National Company; J. J. Jones, Valve Gear Designer of the American Locomotive Company; L. D. Freeman, Ass't. S. M. P., of the Seaboard Air Line; H. B. Oatley, Chief Engineer of the Superheater Company; H. H. Vaughan, Constructing Engineer of Montreal, and R. C. H. Heck, M. E., Rutgers College, whose views were not wholly in accord with the Author.

Mr. Oatley criticised the author's derogatory treatment of arches, feedwater heating and superheating, and presented a table giving the per cent of water and fuel saving for superheated steam at several temperatures for various cutoffs and pressures as compared with dry saturated steam.

Mr. Eksergian's very valuable paper on Stresses in Locomotive Frames was received too late to admit of proper preparations for discussion on a subject of such importance, and with such varied angles, and it is planned to have it re-submitted at some future meeting. The importance of this paper as a basis for research in frame stresses was pointed out by W. E. Woodward, Chairman of the Research Committee, while others who spoke were: A. H. Houston, George M. Eaton, Selby Hoar, Clement F. Street and W. E. Symons. The paper on Mechanical Drafting of Locomotives, by F. H. C. Coppus was read and quite thoroughly discussed. The discussion was opened by William Elmer of the Pennsylvania Railroad, who pointed out that on one of their Pacific type locomotives the consumption of coal reached 10,000 lbs. per hour, and for proper combustion, on a basis of 10 lbs. air to 1 lb. coal, and 13 cu. ft. of air per lb., the fan would be called on to deliver 100,000 lbs. of air per hour. This would amount to 1,300,000 cu. ft. per hour at atmospheric temperature, and at a temperature of 600 deg., which is to be expected in the front end, the volume would be double.

W. L. Bean of the New Haven spoke of the needs of improvements in that feature of locomotive design, while Dr. W. F. M. Goss, who is a recognized authority on the subject, pointed out many objectionable features of the present method of drafting locomotives.

W. E. Symons, Consulting Engineer, discussed the paper at considerable length, holding a decidedly opposite view to that of the Author on many fundamental points.

One feature of this meeting which marks an epoch in engineering and industrial progress, is the warning note in Dean Kimball's address, which should be heeded by every man, woman and child of understandable age in this country before it is too late.

Dean Kimball said:

"Unless we can in some manner change our industrial system so that we can more nearly attain universal well being and distribute the fruits of our industry more equitably, we have no reason for believing that our civilization shall endure, and its bones will surely strew the shores of time with those of the greater civilizations that have preceeded us."

Golden Jubilee of the New York Railroad Club

The New York Railroad Club celebrated its fiftieth anniversary with a golden jubilee dinner at the Commodore Hotel, on December 12. The occasion was undoubtedly the most successful and noteworthy event in the history of the organization. More than two thousand members and their guests sat down to the banquet. The new president of the club, Mr. F. T. Dickerson, presided, and the toastmaster was Mr. H. H. Vreeland, vice-president of the Interborough Consolidated Corporation.

In the opening address, President Dickerson referred to the growth and influence of the club and gave much credit to the railway supply members for their co-operation with the railway men in making the sessions and programs educational and inspiring.

In introducing the toastmaster, President Dickerson paid high tribute to Mr. Vreeland, and attributed a large measure of the early success of the club to his many years as president of the organization.

Toastmaster Vreeland reviewed briefly the early history of the club which now has over 2,000 members.

"Originally designed," he said, "to provide a place where members of the Master Car Builders' Association might meet one another in New York, it has grown until now it requires accomodations for its meetings having a seating capacity for from 500 to 700 men representing all classes of railroad and other transportation activity—from the highest to the lowest in the line of vocation, supervision and management; it has membership representation in practically all lands of the civilized globe; its monthly sessions are an open forum where no man need hesitate in freely expressing his opinions and where important questions of vital concern in solving problems of intense interest and affecting as well as advancing the success of transportation activities are so ably handled that the railroads of this country have been saved thousands of dollars in perfection of design and standardizing of practices and methods without having to incur the expenditure of a penny."

He also referred to the fact that the year of 1928 will be the centennial of railroading in the United States, which event he suggested should be celebrated by the entire railroad industry at that time.

The Hon. J. J. Cornwell, general counsel of the Baltimore & Ohio, and ex-governor of the state of West Virginia was introduced. In his address, he dwelt on the value of the advertising columns of the newspaper, to the railroads for telling their story to the public, and said:

"I would put on a tremendous publicity campaign to put the facts as to the railroad situation before the country. The country is simply outgrowing the transportation facilities, just as the big railroad men of the country were predicting a score of years ago, and why? Chiefly because the railroads have been over-regulated and over-restricted and limited in their operations and limited in their earnings.

In referring to the malicious propagandists against the railways he said:

"There is, however, one class of persons with whom I believe the railroad men should deal very plainly, both in the press and on the hustings, and that is the politicians or labor statisticians so-called, as the case may be, who are pouring out a stream of misinformation as to what the railroads are doing or not doing, poisoning the public mind continuously. I don't mean to enter into a billingsgate combat with them, but I would counter with facts and be persistent and courageous about it, meet them wherever and whenever you can.

The other speakers of the evening were: Mr. George A. Post, chairman of the Railroad Committee of the United States Chamber of Commerce; Mr. W. G. Besler, president of the Central Railroad of New Jersey; Mr. John A. Droege, ex-president of the club, and general superintendent of the New York Division of the New York, New Haven & Hartford Railroad; and Mr. Daniel M. Brady, the only living member of the body of 1872, who responded to the compliments paid to him for his long devotion to the interests of the club.

Merchandising Electric Locomotives

The sale and shipment of a 50-ton electric locomotive within a period of five hours was the novel record established recently by the Pittsburgh Office force and shop employes of the Westinghouse Electric & Manufacturing Company. In fact, the circumstances attending the sale of the locomotive, which was taken from stock, indicate that it is one of the very few cases on record of an electric locomotive being sold in a manner similar to the merchandising of staple goods, for the locomotive was actually sold "off the shelf."

A. A. Crawford, an official of the Youngstown and Ohio Railroad, which operates in the soft coal regions between East Liverpool and Salem, O., recently went to the East Pittsburgh Works of the Westinghouse Company to purchase a much needed locomotive, the two Westinghouse-Baldwin locomotives used on the railroad being in service continuously 24 hours every day except four hours on Sunday when they were taken into the shops for oiling and inspection.

Mr. Crawford arrived at the Westinghouse plant at 10:30 o'clock in the morning and immediately entered into negotiations for the purchase of a locomotive. Upon being informed that the Westinghouse company had a locomotive whose general design and operating characteristics, though not duplicates of the locomotives then in service on the railroad, were capable of giving the same service, the railroad official, pressed by a dire need due to the fact that a breakdown of one of the locomotives in use would result in congestion of traffic, signed the contract for the purchase at 3 o'clock that afternoon.

The shop force was notified and, with complete service data on the railroad where the locomotive was to be used, a corps of workers immediately examined the locomotive, testing the motors for insulation, ringing out the main and control circuits and clearing up the other necessary items of inspection. At 4:30 o'clock after the messenger had made his bunk in the cab, the locomotive was in the Pitcairn yards of the Pennsylvania Railroad.

Counting out the hour, while the employes were eating their luncheon, only five hours was required in the sale, inspection and shipment of the locomotives.

The day after the sale, the locomotive was at Leetonia, O., and the following day was placed in service in hauling coal on the Youngstown and Ohio Railroad between Leetonia and East Liverpool, O. It is believed that also the sale, shipment and placing in service of the locomotive within a period of less than three days also established a record in this phase of railroad work.

The rapidity with which the whole transaction and shipment was put through by Westinghouse employes has resulted in much commendation on their efforts by railroad officials and also by others engaged in the construction and shipment of electric locomotives. The locomotive is one of the standard 50-ton, 600-volt type, built by the Baldwin and Westinghouse companies jointly for hauling.

Notes on Domestic Railroads

Locomotives

The Illinois Central is reported to be in the market for 15 Mountain type locomotives, and also a number of Pacific type locomotives.

The Denver & Rio Grande Western has ordered one narrow gauge rotary snow plow from the American Locomotive Company.

The Pere Marquette has ordered 20 switching locomotives from the American Locomotive Company.

The New York, Chicago & St. Louis, is inquiring for 10 switching locomotives, 10 Mikado type and eight Pacific type locomotives.

The Chicago, Burlington & Quincy has ordered 50 Mikado type and 10 Santa Fe type locomotives from the Baldwin Locomotive Works.

The Canadian National Railways are inquiring for 65 locomotives.

The Union Pacific is reported to be inquiring for 78 new freight locomotives.

The Chicago & North Western is inquiring for 18 Mikado and 12 Pacific type locomotives.

The Illinois Central has ordered 85 Mikado type locomotives from the Lima Locomotive Works. This road is expected to place an order for 40 additional locomotives at an early date.

The Louisiana Central has placed an order for one Prairie type locomotive with the Baldwin Locomotive Works.

The Minneapolis, St. Paul & Sault Ste. Marie has ordered 5 Pacific type locomotives from the American Locomotive Company.

The Denver & Rio Grande Western has ordered 10 Mountain type and 15 Mallet type locomotives from the American Locomotive Company.

The Chesapeake & Ohio has ordered 2 Mountain type and 6 Pacific type locomotives from the American Locomotive Company.

Norton Griffiths, Ltd., Brazil, has ordered two four-wheel switching locomotives from the Baldwin Locomotive Works.

The Mexican Railway Company has ordered 10 electric locomotives which will be constructed and equipped jointly by the General Electric Company and the American Locomotive Company.

The Lehigh Valley has ordered 10 locomotive tenders from the American Locomotive Company.

The Illinois Central is said to be in the market for 25 Mountain and Pacific type locomotives.

The Lehigh & New England is inquiring for three Consolidation type locomotives.

The Mesaba Cliffs Mining Company has ordered three switching locomotives from the American Locomotive Company.

The Louisville, Henderson & St. Louis is inquiring for five Pacific type locomotives.

Freight Cars

The Baltimore & Ohio is asking bids for repairs to 2,000 box cars.

The Tennessee Central is inquiring for 1,000 composite gondola cars.

The Denver & Rio Grande Western is inquiring for 500 stock cars of 40 tons' capacity, 100 narrow gauge stock cars and 350 coal cars.

The Great Northern Railway is inquiring for 1,000 U. S. R. A. standard, double-sheathed box cars.

The Southern Pacific will build 300 flat cars and 100 caboose cars in its own shops.

The St. Louis, Troy & Eastern is inquiring for 300 flat bottom gondola cars and 100 dump cars.

The Baltimore & Ohio is in the market for 2,000 hopper and 1,000 gondola cars.

The Muscle Shoals, Birmingham & Pensacola is the market for 100 box cars, 100 coal cars and 200 gondola cars.

The Chicago & Northwestern is inquiring for 3,000 box cars.

The Steamship Fuel Corporation is in the market for 100 70-ton hopper cars.

The United Gas Improvement Co., is in the market for 150 50-ton coal cars.

The Atlantic Coast Line is said to be in the market for 500 sets of 40-ton trucks to be used in the repair of cars in its own shops.

The Chicago, Indianapolis & Louisville is in the market for 300 steel underframes in bodies and other steel members.

The American Turpentine & Tar Co., is in the market for one tank car.

Passenger Cars

The Union Pacific is in the market for 21 baggage and mail cars, 18 observation cars and ten dining cars.

The Philadelphia & Reading has placed an order with the Bethlehem Shipbuilding Corporation for 45 steel suburban coaches, and five combination suburban passenger and baggage cars.

The Missouri Pacific is in the market for thirteen coaches and eight combination passenger and baggage cars.

The Southern Pacific is inquiring for 11 steel baggage cars, 35 steel combination mail and baggage cars, 60 steel coaches. This equipment to be used in main line service.

The New York Central has ordered 30 baggage cars, and 20 coaches from the American Car & Foundry Co., ten coaches and 15 combination passenger and baggage cars from the Pressed Steel Car Co., and 30 coaches and 20 multiple unit steel motor cars from the Standard Steel Car Co.

Buildings, Structures, etc.

The Chicago, Rock Island & Pacific has awarded a contract to the International Filter Company, Chicago, for the construction of a water treating plant at Peoria, Ill. This carrier has also awarded a contract to the Railroad Water & Coal Handling Company, Chicago, for the construction of a water treating plant at Manly, Ia.

The Central Railroad of New Jersey is planning the construction of locomotive and car repair shops for a site near Allentown, Pa. The estimated cost is about $300,000. The present locomotive shops at Ashley, Pa., and the car repair plant at Mauch Chunk, Pa., will be removed to the new location, with additional equipment for increased capacity.

The Wabash is said to be planning the construction of locomotive repair and machine shops at Decatur, Ill.

The Great Northern is said to be planning for the construction of a new engine house and repair shops at St. Cloud, Minn.

The Virginia is reported to have awarded a contract for what is said to be the largest coal handling plant in the world, to the Alliance Machine Co., Alliance, Ohio. The plant is to be erected at Norfolk, Va., and will include two car dumpers, each handling two cars tandem at a time, two movable loading towers and four 130-ton transfer cars. The dumpers will have a capacity for handling coal cars of 120-ton capacity. The plant will be entirely electrically operated and will require 42 motors ranging from small sizes to 450 h.p. Each dumper will be operated by two 450 h.p. motors. The plant will have a maximum capacity of 5,000 tons per hour. It will require approximately 3,700 tons of steel, including several hundred tons of castings, and in addition steel trestles will require 6,000 tons of steel.

Items of Personal Interest

W. S. Tasker has been promoted to master mechanic on the Atchison, Topeka & Santa Fe at Wellington, Kans. He was formerly superintendent of shops at Clovis, New Mexico.

D. A. Cassiday has been appointed day engine house foreman on the Baltimore & Ohio at Hazleton, Ind.

A. W. Kirkland has been appointed superintendent of motive power of the Atlanta, Birmingham and Atlantic with headquarters at Fitzgerald, Ga.

G. T. De Pue, formerly mechanical superintendent of the Ohio region of the Erie, has been transferred and is now mechanical superintendent of the Chicago region with headquarters at Chicago, Ill.

R. C. Bardwell has been appointed superintendent of water supply of the Chesapeake & Ohio with headquarters at Huntington, W. Va. He was formerly engineer of water service of the Missouri Pacific at St. Louis, Mo.

F. C. Ryan has been appointed night engine house foreman of the Baltimore and Ohio at Hazleton, Ind.

D. Davis, assistant master mechanic of the Lehigh Valley at Easton, Pa., has been promoted to master mechanic with headquarters at Coxton, Pa.

J. F. Sheahan has been appointed mechanical engineer of the Atlanta, Birmingham & Atlantic with headquarters at Atlanta, Ga.

H. L. Hanna has been appointed mechanical engineer of the New York, Chicago & St. Louis with headquarters at Cleveland, Ohio. Mr. Hanna succeeds T. A. Lowes, retired.

Charles E. Hill has been appointed general safety agent of the New York Central Lines.

Lon S. Lasswell, has been appointed road foreman of engines of the Illinois Division, and Walter R. Lane has been appointed road foreman of engines of the Missouri

Division of the Atchison, Topeka & Santa Fe, both with headquarters at Shopton, Ia.

William Hacker has been appointed night roundhouse foreman of the Chicago, Rock Island & Pacific at Herrington, Kans.

C. E. McCloskey has been appointed master mechanic of the Gulf Coast Lines, with headquarters at Kingsville, Tex.

H. V. Hecox has been appointed road foreman of engines, and **Benjamin Erwin** has been appointed traveling fireman on the New York Central at Middleport, O.

R. E. Detrick has been appointed roundhouse foreman of the Chicago, Rock Island and Pacific at Shawnee, Okla.

J. W. Small has been appointed chief mechanical officer of the Chesapeake & Ohio, and will have entire charge of the mechanical department.

E. M. Brockmayer has been appointed road foreman of engines of the Detroit-Canadian Division of the Pere Marquette with headquarters at Detroit, Mich.

Supply Trade Notes

The Westinghouse Air Brake Company, of Wilmerding, Pa., has announced the following appointments in the Eastern District of its organization, effective January 1, 1923:

E. W. Davis, heretofore stationed at New York as Representative, Westinghouse Traction Brake Company, is promoted to Representative, Westinghouse Air Brake Company and Westinghouse Traction Brake Company, in charge of the Boston Office.

G. H. Martin, heretofore Mechanical Expert for the Westinghouse Traction Brake Company, is promoted to Representative, Westinghouse Air Brake Company and Westinghouse Traction Brake Company, with headquarters at Boston.

F. H. Whitney, heretofore Representative of the Westinghouse Air Brake Company, has been promoted to Export Representative, Westinghouse Air Brake Company and Westinghouse Traction Brake Company, with headquarters at New York.

H. B. Gardner is appointed Representative, Westinghouse Air Brake Company, reporting to the New York Office. Mr. Gardner was formerly connected with the Locomotive Stoker Company of Pittsburgh whose service he entered in June, 1916. After serving for some time in the Stoker Company's Shops, he was made Mechanical Expert and during the last few years was attached to the Sales Department of that Company.

Ray G. White, formerly Chicago Branch Manager of the B. M. Jones & Co., Inc., has been appointed Eastern Railroad Sales Agent for the **McInnes Steel Co., Ltd.,** of Corry, Pa., manufacturers of Hammered Crucible Tool Steels. Mr. White has opened a temporary office at 56 Murray St., New York City.

The Commonwealth Steel Company, of St. Louis, Mo., has announced that effective January 1, **Frank L. Morey,** Secretary of the Company will assume the duties of Treasurer.

Harrison Hoblitzelle has been appointed Manager of Purchases and Supplies. He will also continue his duties as Assistant Treasurer and perform such other duties as may be assigned him by the President or Senior Vice-President.

Cecil R. Pilsbury has been appointed General Auditor in charge of auditing at both the Plant and City Office, and with such other duties as may be delegated to him by the President or Senior Vice-President.

The W. S. Murrian Company, of Knoxville, Tenn., has been appointed field representative for the southern part of the United States, of the Mahr Manufacturing Company of Minneapolis, Minn.

The Standard Coupler Company of New York has announced that **E. F. Pride,** formerly secretary of the company has been elected treasurer, and **C. T. Lynch** has been elected secretary. **A. P. Dennis,** formerly vice-president and treasurer, has resigned.

Obituary

Herbert Hall Hewitt died at his home in Buffalo, N. Y., on December 19. Mr. Hewitt had been in ill health for over two years. He was president of the Magnus Company, New York; the Reading Car Wheel Company, Reading, Pa.; the Hewitt Rubber Company, Buffalo, N. Y., and the St. Thomas Brass Company, St. Thomas, Ont., Canada.

John T. Chamberlain died at Medford, Mass., on December 12. Mr. Chamberlain at the time of his retirement from railroad service in 1907 had been master car builder of the Boston & Maine. He was president of the Master Carbuilders' Association in 1901.

W. B. Everest, General Traffic Manager, Westinghouse Electric and Manufacturing Company, died December 5 at his home in Pittsburgh, Pa., where he had been confined for one week with pneumonia.

L. L. Dawson, who was superintendent of motive power of the Ft. Worth & Denver City at Childress, Texas, when he retired in 1918, died at Champaign, Ill., December 11.

Reports Show Greater Efficiency in Service

The monthly summary of operating statistics of the Class 1 railways, just prepared by the Bureau of Railway Econimics, shows the improvements and increases in railway operation and traffic in the first nine months of this year.

It shows that there has been an increase of about five and a half million train miles and an increase of six million locomotive miles. Freight car miles have increased about 360 million miles in the first nine months of this year, compared with last year. In the first nine months of last year only 62.8 per cent of the freight car movement represented loaded cars. In the same period this year 66.9 per cent of the cars moved have been loaded cars.

In 1921 the average number of freight cars per train was 38.2, while for the same period this year the average number of cars per train has been 38.6. A year ago the average number of gross tons in a train was 1,430, and for the first nine months of this year is was 1,454.

Another review, prepared by the Bureau of Railway Economics, for the first ten months of this year shows that the average number of miles moved per day per freight car in service was 26.6 miles in October, which was higher than in any previous month.

The review also shows that the average number of tons carried per car was 27 tons. This is a higher average than in any month this year.

New Australian Trans-Continental Line

The Prime Minister of Australia recently announced the Government's intention of resuming at an early date the construction of the North-South Transcontinental railway, to connect Adelaide, S. A., with Port Darwin, N. T.

Before the transfer of the Northern Territory to the federal government in 1911, the State of South Australia had built a three-foot six-inch line from Port Augusta, eastern terminus of the East-West Transcontinental line to Oodnadatta, S. A., 478 miles, and a similar line from Port Darwin, N. T., about 200 miles south to Kathanine River. The Commonwealth Government on accepting the transfer agreed to construct the approximately 1,100 miles necessary to join these two sections and make the railway a transcontinental line, but nothing serious has yet been done about it. It is now stated that the federal government will proceed with the extension of the Port-Augusta-Oodnadatta section as far as Alice Springs, N. T., about 300 miles. This section of Australia, on account of lack of rain, is of little agricultural and doubtful pastoral value, but the McDonnell Ranges in which Alice Springs are located are believed to be richly mineralized. It is estimated that the cost of this work will be $14,500,000, that the necessary rolling stock to operate it will cost about $700,000, and that the annual loss on operation will be about $900,000.

American Society for Testing Materials

The twenty-second Annual Proceedings of the above-named society, the year of 1922, has just been issued. The proceedings are published in two parts:

Part I (1023 pp.) contains the annual report of 34 of the standing committees of the society, together with the discussion thereon at the annual meeting, and 84 tentative standards which have either been revised or are published for the first time.

Part II (591 pp.) contains 36 technical papers with the discussion, the annual address of the president and the annual report of the Executive Committee.

The technical papers contain valuable information on results of investigations by experts in the field of engineering materials and the reports of the committees cover Ferrous and Non-Ferrous Metals, Cement, Ceramics, Concrete, Gypsum, Lime, Preservative Coatings, Petroleum Products, Road Materials, Coal and Coke, Waterproofing Materials, Electrical Insulating Materials, Shipping Containers, Rubber Products, Methods of Testing, and Nomenclature and Definitions.

Address the Secretary, C. L. Warwick, American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa., for further details.

History of Boiler Water Treatment

"Thirty-five Years of Progress Boiled Down," is the title of a booklet recently issued by the Dearborn Chemical Company, Chicago, Illinois.

In this booklet the company has endeavored to emphasize the scientific handling of the water problem from every angle by their experts. It tells how thoroughly they go into the matter, including a survey of the water conditions; the complete mineral analysis; study of the plant equipment and operating conditions; expert advice and assistance from the standpoint of practical power production engineering; followed by laboratory control after treatment is installed, including analysis of the water from time to time and adjustment of the material to suit changing conditions that may develop.

Manchuria; Land of Opportunities

The story of the amazing transformation that has come in Manchuria with the building of an American-equipped railroad system and American-equipped coal and iron mines, steel, electric and industrial plants, is told in a profusely illustrated book, "Manchuria: Land of Opportunities," that has recently been issued by the New York office of the South Manchuria Railway.

This section of China, only a few years ago known as "The Forbidden Provinces," has attracted hundreds of millions of new capital since the Russo-Japanese War, when Russia's rights in the country were transferred to Japan. Dairen, the principal shipping port, has been transformed from a little fishing village to a modern city of 200,000 people, ranking next to Shanghai in volume of trade. The foreign trade has grown to $500,000,000 a year, of which $100,000,000 is in soya beans, the "modern manna" which is used for making a hundred useful products, from breakfast foods to printing inks.

A paragraph from the book gives an idea of its appeal to American readers. This is taken from the opening chapter on Commerce and finance:

> The American traveler in Manchuria today, who rides in comfort in a Pullman sleeping car behind a Baldwin locomotive, over 100-pound Pittsburgh rails, from the modern port of Dairen, with its beautiful plaza, and its great modern banks, business houses and public buildings; and then northward through cities lighted by electricity, with modern railway stations, paved streets, modern hotels, schools, hospitals and scientific laboratories; past American-equipped steel works, coal mines and factory buildings—with such a magic transformation before his eyes the traveler finds it difficult to believe that only a few years ago this country was the home of the Manchu rulers of China and a forbidden land to world commerce.

In addition to a hundred photographic illustrations, the volume carries a number of graphic charts, a new map of Manchuria, and very complete statistical data covering transportation, agriculture, manufacturing, shipping, foreign trade and banking.

Metropolitan Subway and Elevated Systems

The principal characteristics of several great rapid transit systems from an electrical engineering viewpoint are presented in Bulletin 44,018 issued by the General Electric Company.

The facilities for power production, transformation, transmission and utilization are outlined briefly for each of the systems in the cities of Boston, Chicago, New York and Philadelphia.

The General Electric Company has taken a most important part in the manufacture of various types of apparatus for use on all of these systems. Exhaustive engineering studies and tests have been conducted by trained engineers to insure to each railway company the selection of exactly the proper equipment for the most reliable and efficient operation.

In the spring of 1893 the "Intramural Railway" was constructed at the World's Fair at Chicago and equipment was furnished by the General Electric Company for its operation. In 1895 the Metropolitan West Side Elevated Railway in Chicago was equipped on the same general plan and later in the year the Lake Street Elevated (Chicago) and Brooklyn Bridge (New York). In July, 1897, a train of six motor cars was successfully operated in the presence of engineers of the South Side Elevated road and less than a year later 120 cars were in operation in Chicago, and the use of steam locomotives had been abandoned.

In subsequent traction developments the name of the General Electric Company has been equally prominent. The Curtis turbine, generating and substation apparatus of all kinds, the commutating pole and ventilated motor, the Type K controller, high voltage direct current equipment and more recently the automatic substation.

Railway and Locomotive Engineering

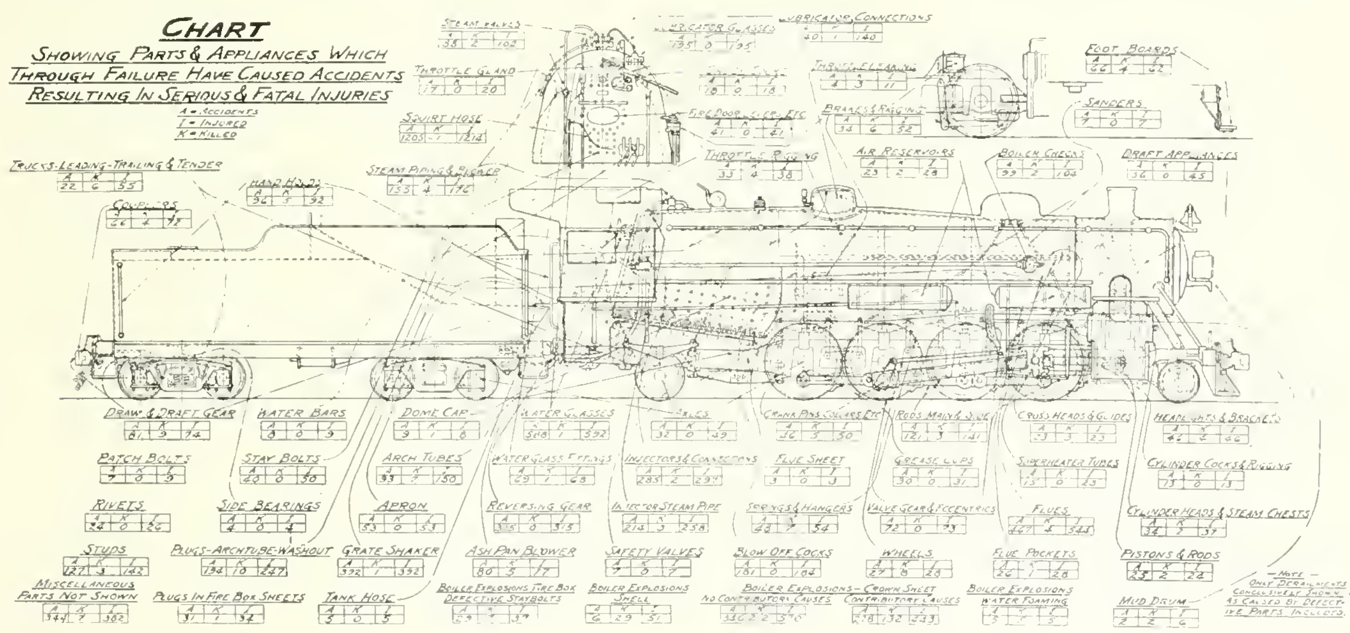
A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXVI | 114 Liberty Street, New York, February, 1923 | No. 2

Locomotive Accident Report

Bureau of Locomotive Inspection

The Interstate Commerce Commission has issued the eleventh annual report of the Bureau of Locomotive Inspection. It is signed by the chief inspector A. G. Pack and contains a mass of interesting and valuable information. Among other things the report contains a diagram of a



locomotive, with reference tabulations of the numbers of the various types of accidents with the numbers of persons killed and injured. This diagram is reproduced herewith and shows the parts and appliances of the locomotives which, through failure, have caused accidents resulting in serious and fatal injuries.

It appears that a great deal of improvement has been brought about in the past ten years though there is still room for more. For example, in 1912, there were 856 accidents due to the failure of boilers and appurtenances only in which 91 persons were killed and 1,005 were injured. For 1922 these figures were: 273 accidents, 15 killed and 318 injured; while the total number of accidents in 1922, including boiler and machinery was 622 in which 33 persons were killed and 709 were injured.

Attention is called to the report and recommendations on water gauges, made by the bureau and published in Railway and Locomotive Engineering for September, 1920. Water columns as there recommended have been applied to practically all new locomotives constructed during the past two years, and on a large number of old locomotives on most of the large railway systems throughout the country, and it is gratifying to advise that, with very few exceptions, the mechanical and other officials have accepted these recommendations and are carrying them out in varying degrees.

Investigation of accidents during the year, where the fusion or autogenous welding process was involved, supports our position previously taken that the process has not yet reached a state of perfection where it can be safely depended upon in boiler construction and repair where the strain to which the structure is subjected is not carried by other construction which conforms to the requirements of the law and rules, nor in fire box crown-sheet seams where overheating and failure are liable to occur, nor its excessive use in repairing long and numerous cracks in side sheets.

Our records continue to show that approximately 80 per cent of all autogenously welded seams involved in so-called "crown-sheet failures" have failed, while 16.9 per cent of riveted seams have failed under like conditions.

The fatalities where sheets tore have been seven and one-half times as great as where they did not tear. From July 1, 1916, to June 30, 1922, autogenously welded seams were involved in 22.1 per cent of the crown-sheet failures, while 44.1 per cent of the total killed in crown-sheet accidents were killed where the autogenously welded seams were involved.

A large number of accidents have been caused by defective grate-shaking apparatus, the majority of which were caused by the shaker bar not properly fitting the fulcrum lever. This condition on many roads has been brought about because of no standard design being maintained, making such parts interchangeable. We have records of many such accidents where permanent and fatal injuries resulted. Therefore it should be required that all carriers adopt a standard whereby shaker bars can be made interchangeable on all of their locomotives with a proper fit.

Among the recommendations made is one that all locomotives not using oil for fuel have a mechanically operated fire door so constructed that it may be operated by pressure of the foot on a pedal or other suitable device located on the floor of the cab or tender at a proper distance from the fire door, so that it may be conveniently operated by the person firing the locomotive.

This recommendation is based on the results of many investigations of boiler failures of such character as to permit the steam and water contained in the boiler at the time of the accident to be discharged into the fire box, many times being directed toward the fire door.

The old swing-type door, which is largely used at present, is almost invariably blown open in case of such accidents and permits the discharging steam and boiling water, with the contents of the fire box, to be blown into the cab of the locomotive, seriously and most frequently scalding and burning the persons therein. Such accidents frequently occur while coal is being put into the fire box, and with the fire door necessarily open, and under such circumstances it is impossible for it to be closed.

The automatic fire door would remain closed, if closed, when the accidents occur. If open, it would automatically close the moment the operator's foot was removed from the operating device, thus preventing the direct discharge of the scalding water and fire into the cab of the locomotive with such serious results.

The automatic fire door is not a new and untried device, as there are thousands of them in service, and they are required by law in some States. The automatic fire door is also of great value in prevention of serious cracks and leaks in fire-box sheets by limiting the time the fire doors are open when placing coal on the fire, thus reducing the amount of cold air admitted, which causes loss of temperature and consequent expansion and contraction and the setting up of great strains.

Their use is also very valuable in the conservation of fuel which is one of the principal costs of operation.

Another recommendation is that a power-reversing gear be applied to all locomotives and that air-operated power-reversing gear have a steam connection with the operating valves conveniently located in the cab, so arranged that in case of air failure steam may be quickly used to operate the reversing gear.

This recommendation is based on the fact that 315 accidents have occurred, due to the failure of some part of the reversing gear, resulting in serious injury to 315 persons. Such accidents can be practically eliminated by the application of power-reversing gear, which will not only add to the safety of operation of a locomotive but will add greatly to its efficiency.

The report then goes on to recommend the use of power grate shakers, because of their value in avoiding casualties and saving fuel. The application of a bell ringer is also recommended because the attention of the engineer and fireman are too fully occupied, to require that they should devote any time to the routine work of ringing the bell.

Again it is suggested that the cabs of all locomotives not equipped with front door or windows of such size as to permit of easy exit have a suitable stirrup or other step and a horizontal handhold on each side approximately the full length of the cab, which will enable the enginemen to go from the cab to the running board in front of it, handholds and steps or stirrups to be securely fastened with bolts or rivets, the distance between the step and handhold to be not less than 60 inches nor more than 72 inches.

This recommendation is based on the result of investigation of accidents of a character which make it impossible for enginemen to remain in the cab and which compel them to make exit through the cab window to the ground or running board. While locomotives are operating at a high speed to be compelled to jump from the cab window is exceedingly dangerous and invariably results in serious if not fatal injury.

The front doors or windows on modern locomotives are so small that they will not permit the enginemen to pass out through them, thus making it necessary to climb over the roof of the cab or out through the side window when necessary to go from the cab to running board in front while in motion.

Such attachments can be applied at a nominal expense and practically without delay to the locomotive and would add greatly to the safety of the employees. Accidents resulting in fatal injury which have been investigated by this bureau show that injury and death would have been avoided had these appliances been in use.

The report concludes with a reiteration of the recommendations regarding water columns and gauges that was offered in the original report to which reference has been made. It was a recommendation based on such a careful investigation that it will probably do more than anything heretofore proposed to reduce crown sheet failures by the avoidance of false water level indications.

Locomotive Costs for 1922 Decreased

A report of the Interstate Commerce Commission, prepared by the Bureau of Statistics and just made public, shows that while costs of railroad operation as seen from selected items for the first ten months of last year were less than for the same period in 1921, the costs in October were in excess of those of the previous year.

Engine-house expenses per freight-train-mile in October last fall were 9 6/10 cents, and in the same month in 1921 8 6/10 cents, but for the ten months of last year these costs were 1 cent, and for the same period in the previous year, 1 and 1/10 cents.

In October, 1921, the cost of fuel per freight-train-mile was 53 cents, and in October last year about 60 cents, while for the ten-month period last year this cost was 54½ cents, compared with 58 8/10 cents the year before.

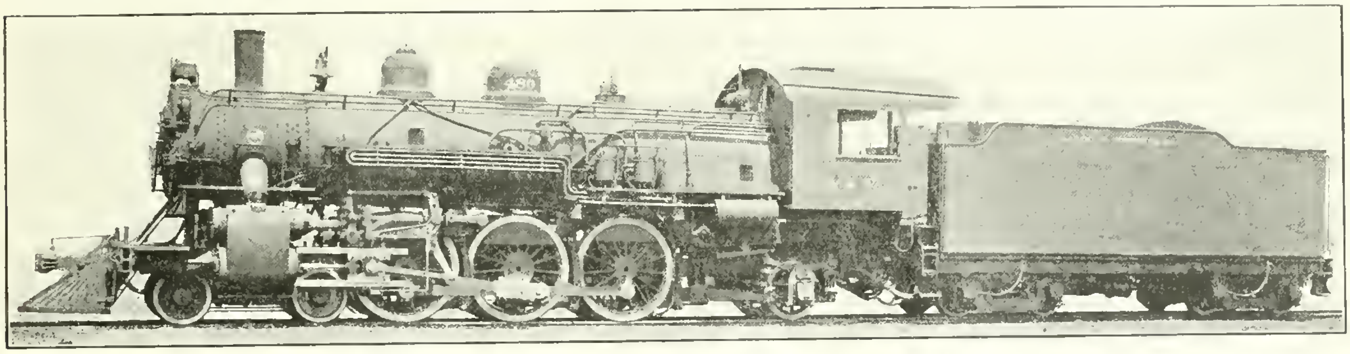
Locomotive supplies in October last year cost the roads an average of 11 6/10 cents per freight-train-mile, and in the previous year 10 9/10 cents. For the ten months locomotive supplies averaged 10½ cents in 1922, and 12 1/5 cents in 1921.

The cost of coal per net ton—which is the invoice cost plus freight—in October last year was 4.27 per ton, which was considerably in excess of $3.71, the price paid in October, 1921. For the ten months ended with October last year the cost had averaged $3.98 per ton, which was less than the average of $4.19 in 1921.

New Locomotives for the Alabama & Vicksburg

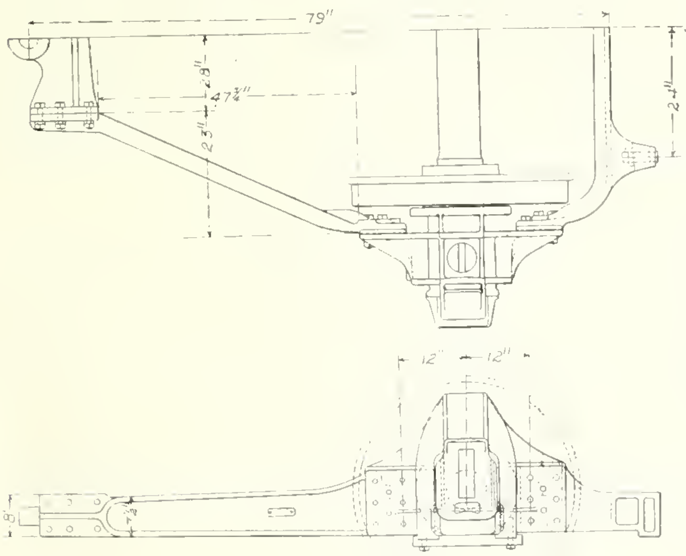
Interchangeability of Parts a Feature of These Pacific and Mikado Types

The Alabama & Vicksburg Ry. and the Vicksburg, Shreveport & Pacific Ry. together constitute an east-and-west line extending from Meridian, Miss., to Shreveport, La., a distance of 313 miles. The first-named road extends from Meridian to Vicksburg, 140 miles. Grades and curvature are comparatively light, as the maximum grades on the main line are one per cent and the curves 6 degrees. The track is laid with 75-pound rails, necessitating the use of locomotives having limited wheel-loads.



PACIFIC TYPE LOCOMOTIVE FOR THE ALABAMA & VICKSBURG RAILWAY

This railway has in service a number of Pacific and Mikado type locomotives, which are of special interest in view of the large number of interchangeable detail parts used in the two designs. The illustrations show the latest development of each of these types, as built



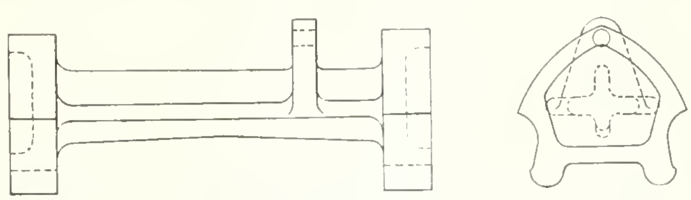
TRAILER TRUCK, PACIFIC LOCOMOTIVE, ALABAMA & VICKSBURG RAILWAY

in 1922. Service conditions in this case are such that the feature of interchangeability referred to above can be utilized without in any way reducing the efficiency of either type.

These locomotives have the same size cylinders, and the wheel spacing is such that boilers of the same length can be applied. This permits the use of interchangeable boilers and boiler accessories; also cylinder castings, pistons and rods, piston valves, crossheads, driving boxes, rear trucks and various other machinery and running gear details. The cabs also interchange as well as a large amount of the equipment and fittings, such as bells, sand-boxes, cocks and valves, etc. The tenders are also interchangeable.

These locomotives use superheated steam, and have straight-top boilers with combustion chambers of the Gaines type. The total length of the firebox is 110-33/16", and of this the gates occupy 87". Power operated grate shakers are applied. The front end is fitted with the Master Mechanics' standard self-cleaning arrangement.

The Young valve gear is used on these locomotives, and is controlled by the Ragonnet type "B" power reverse mechanism. The valves have a steam lap of 1⅜" and are line and line on their exhaust edges; and they are set with a travel of 9" and a lead of ¼". The piston heads are of cast steel, and the driving and rear truck axles are of chrome-vanadium steel. The driving axles are hollow bored. Leading trucks of the constance resistance type are used on both locomo-



CONSTANT RESISTANCE ROCKER FOR PACIFIC TYPE LOCOMOTIVE

tives, and the rear trucks are of the Hodges type with jointed spring hangers which take the side swing.

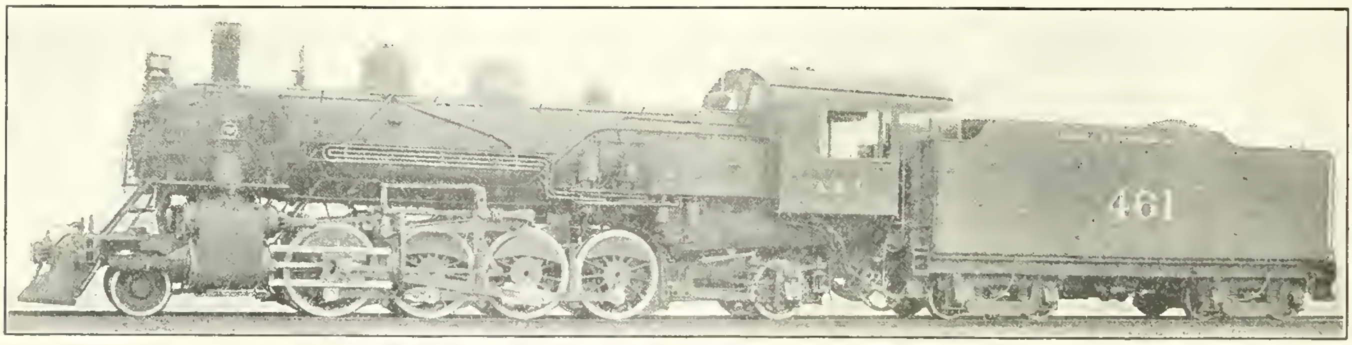
The rear truck is of a very simple construction and is not called upon to carry any of the weight of the engine and serves merely as a frame to guide and hold the trailing wheels in line. In short it is a modification of the Bissel without the details that usually characterize that construction.

The pivot bearing is a steel casting with its center 79 in. from the center line of the trailing wheels. This is bolted to and held in place by two diagonals that connect it to the pedestals, and these, in turn are tied together by the crosstie or end piece; all of which are of steel castings. The whole truck is thus formed of six pieces.

The pedestal holds the axle boxes in place and on these the weight is placed, and without any contact with the truck itself. The method of weight distribution and equalization is clearly shown in the engraving of the equalization and spring suspension, which is self-explanatory.

In order that the bolster and the rocker may always maintain the same relationship to each other, they are connected together by the link, as shown in the small partial assembly of the truck.

The connection is made by a link attached to the arm that rises between the ends, as shown in the side elevation of the rocker.

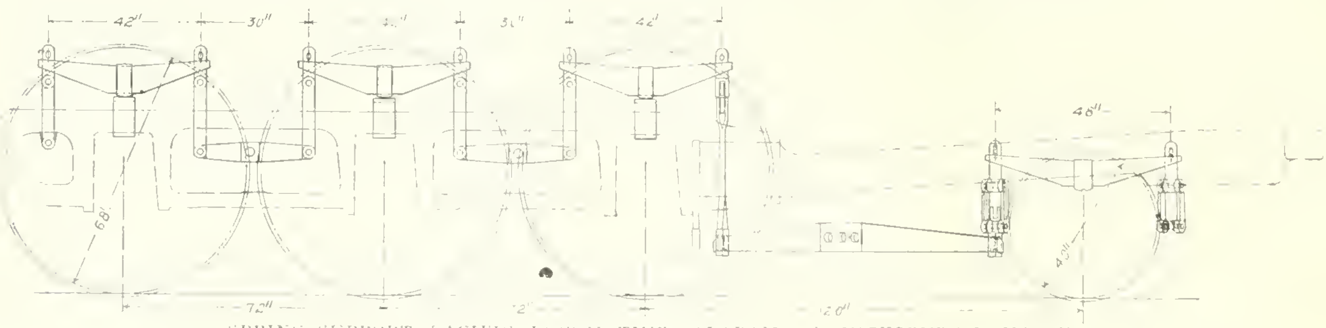


MIKADO TYPE LOCOMOTIVE FOR ALABAMA & VICKSBURG RAILWAY

The side framing is carried at five points of support in all; three at the drivers, one between the rear drives and the trailer on the slab portion of the frame and the fifth back of the trailing wheels.

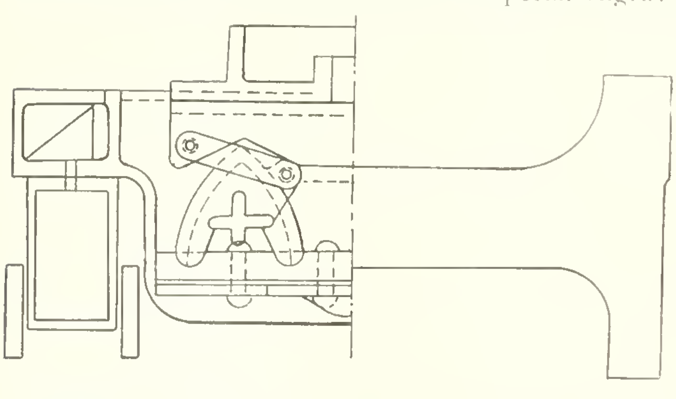
This is not unusual but is shown to illustrate the method used in these particular engines, by which no load is put upon the frame of the trailing truck.

The frames of the engines are designed for severe service and are of liberal sections, with large radius fillets and strong transverse bracing.



SPRING SUPPORT, PACIFIC LOCOMOTIVE, ALABAMA & VICKSBURG RAILWAY

The constance resistance feature of the forward truck is that developed by the Franklin Railway Supply Co. and consists in carrying the center-plate or bolster upon the point of a heart-shaped rocker. The details of this rocker is shown in the special engraving. It is of a steel casting with the two heart-shaped ends connected by a cross-shaped bar. The lower points or legs of the heart rest on the spring plank and as the bolster moves to and fro the weight rests first on one side and then on the other.



SECTION OF FRONT TRUCK SHOWING CONSTANT RESISTANCE SUPPORT, PACIFIC LOCOMOTIVE, ALABAMA & VICKSBURG RAILWAY

The tenders have one-piece cast steel frames, and are carried on rolled steel wheels. They have capacity for 10,000 gallons of water and 16 tons of coal.

Further particulars are given in the following tables of dimensions:

Cylinder diameter	22 in.
Piston stroke	28 in.
Diameter of boiler	66 in.
Steam pressure	200 lbs.
Firebox length	110⅜ in.
" width	75⅞ in.
Tubes, diameter	2 in.
" number	172
Superheater tubes diameter	5⅜ in.
" " number	24
Heating surface firebox	171 sq. ft.
" " tubes	2,373 sq. ft.
" " arch tubes	29 sq. ft
" " total	2,573 sq. ft.
Superheater surface	542 sq. ft.
Grate area	46 sq. ft.
Tender capacity, water	10,000 gals.
" " coal	16 tons

The above dimensions hold for both types of locomotives. The special dimensions of the types of locomotives are:

	Pacific	Mikado
Diameter driving wheels	68 in.	57 in.
Driving wheel base	12 ft. 0 in.	15 ft. 0 in.
Engine wheel base	33 ft. 0 in.	33 ft. 6 in.
Total wheel base, engine & tender	67 ft. 7¾ in.	68 ft. 1¾ in.
Weight in working order:		
Driving wheels	138,210 lbs.	168,900 lbs.
Front truck	47,030 lbs.	21,800 lbs.
Rear truck	38,060 lbs.	32,600 lbs.
Total engine	223,300 lbs.	223,300 lbs.
Engine and tender	408,000 lbs.	408,000 lbs.
Tractive force	33,900 lbs.	40,400 lbs.

Some Features of Freight Car Design

The Relation of Couplers and Draft Gear to Maintenance and Operating Expense

By W. E. Symons

In considering questions of, or in relation to the superstructure of freight equipment, particularly the "Draft Line," couplers and draft gear are inseparable, and while it is the purpose of this article to dwell at greater length on the latter it is necessary to consider the former, if for no other reason than that they were originally combined in one.

Among the earlier if not the first freight cars some were owned by the shipper and moved with horses, the device then used to connect or hitch the horse to the car in the United States was a hook bolt through the end sill of car frame, and this device is still used by some railroads abroad, and is commonly used in the farming or agricultural industry in this country.

For single vehicles primarily moved by horses, and later on when two or more were fastened together and a small engine was used to haul them, this hook bolt answered the purpose, and was in reality a coupler and draft gear combined.

As the railway business developed, however, and it became necessary to couple several freight cars together, the hook bolt was found inadequate and a draw head casting was used in its place, by which means a link and pin made the connection, and from this was then developed the link and pins coupler with tail bolt for springs, which was in quite general use until 1892, at which period the vertical plane coupler was adopted by the M. C. B. Association, and the railways were by Act of Congress, February 27, 1893, given until January, 1898, to equip all their cars so that train men could couple and uncouple cars without the necessity of going between the cars. As a result of this development the present M. C. B. vertical plane coupler came into general use and is not only standard on all equipment in the United States but is also being applied in many foreign countries, where for various reasons a less efficient device has been used.

During the foregoing period, particularly the earlier stages, the terms Draw Bar and Draft Gear were synonymous, meaning the same, and not until long after adoption of the M. C. B. vertical plane coupler did the question of draft gear, as separate from the draw bar, receive much attention, and even then the idea of, or necessity for a high capacity shock absorbing device, equally effective for buffing and pulling shocks was recognized by only a very few men of broad comprehensive vision.

Mr. George Westinghouse was no doubt the first to realize the great damage to cars and contents, both from buffing and pulling shocks, also from the sudden action of stored up energy in draft and truck springs, following the release of air brakes, and to invent a friction shock absorbing device to minimize or prevent it.

The first device brought out by Mr. Westinghouse was known as their D-3 gear, and following many improvements have developed their present type N. A. for heavy freight service.

It was many years after the introduction of the Westinghouse D-3 friction gear before designing engineers and railroad men in general took much interest in this or kindred devices, in fact even today many are still undecided as to the true function of, or necessity for, a high capacity shock absorbing device, and among those who favor their use there is a lack of agreement and effort toward a uniform standard, and in this particular respect there is now a "weak place" in the otherwise well designed draft line of our freight equipment.

As the tractive power of our freight locomotives went up from 35,000 to 40,000, then from 60,000 to 80,000 and above 100,000 for Mallets, with corresponding heavy trains, and hump yards where cars received buffing shocks from a few hundred thousand foot-pounds up to and above one million foot-pounds, it was clear to anyone with an analytical mind that the old spring gear or even a friction gear of 160,000 to 200,000 pound capacity did not afford ample protection, and as a result both cars and contents were suffering much injury, which is clearly reflected in loss and damage claims, life and use of cars, and extremely high cost of maintenance.

Standardized Draft Gear

It would be difficult to estimate the commercial or money value to the railways of the United States resulting from standardization of car couplers, but when we recall that anyone of more than two and one quarter million freight cars, in which was earned last year more than four and one quarter *billion dollars* will couple by impact, with any and all cars, it is in substance a high tribute to those who gave so generously of time and effort to this great achievement in railway engineering.

No other country in the world can claim advancement on so stupendous a scale and with such obstacles to overcome, but in taking credit due it is proper to state that equal or corresponding advancement has not been made in all other parts of car design and construction, and to the writer it seems that draft gear is at present one of the more essential parts of freight cars that to a considerable degree, has been allowed to lag behind, while as a matter of fact it should be given precedence over some others that in many respects are of less importance.

A house or closed car with a leaky roof, and therefore unfit for flour, grain and certain high grade merchandise shipments, can still be used for many other commodities not affected by the elements, if the trucks, brakes and draft gear is all right, but if either of the latter are defective the car cannot be used at all in *any* service, and as the question of brake efficiency seems to be almost wholly one of proper care and maintenance, with trucks on pretty much the same basis, we then find that the draft gear of today, one of the most essential features of car design, farther from standardization, interchangeability or uniform capacity than any other part of a freight car, although there is no other single part of the complete unit, of the same relative cost and importance.

Financial Features

That a more comprehensive idea of the importance of draft gear and its attachments bear to a freight car, and its relation to, or influence upon financial problems of operation and maintenance may be formed, some facts and figures may be used to good advantage.

First, it may be said without fear of successful contradiction that if freight equipment were handled with the same care and caution as passenger equipment, the annual savings in (a) damage to cars, (b) shortened life of cars, (c) loss of service and (d) loss and damage of freight would run into many hundreds of millions of dollars. As there are no definite figures on all these items some will be estimated.

Damage to Cars

It has been claimed by experts in freight car maintenance that about 82 per cent of repair costs are due to rough treatment or abuse and about 18 per cent to actual wear and tear in ordinary service. The writer believes the expense chargeable to rough treatment runs into many millions but thinks 82 per cent too high. Sixty per cent chargeable to rough treatment, with 40 per cent as the amount which could and should be at least partially saved is used as a more conservative figure.

Freight train car repairs (one year)	$427,750.095
Amount to be saved	40%
	$171,100,038.00

Loss of Service

The item of loss of service is not difficult of calculation, and does not speak any too well for the conditions which obtain on most of our railways with respect to cars out of service for repairs. Freight car repair facilities, and the standard of physical condition should be such that not more than 5% of revenue cars would be out of service awaiting for or undergoing repair, in fact 3½% has often been maintained by some roads over considerable periods of time. There has been for some time from 9 to 12% of freight cars out of service in bad order, which is about 5% too high, therefore in this calculation an excess of 5% will be used by which we get the following results:

Total freight cars	2,380,036		
	5% Excess		Idle Capital
	119,001 ×	1,000	$119,001,000
			6%
			$7,140,090
Average earnings per car per year	$2,042 ×	119,001	= $243,000,042
Interest on investment			7,140,090
Amount involved			= $250,140,132

and to this may be added a fair rental value of the tracks necessary to store or park out this defective equipment, which will add materially to the above amount.

Loss and Damage to Freight

The term loss and damage to freight is to some extent a misnomer for much of the sum total is little short of *pure blackmail.* The actual amount, however, legitimately due is large enough, running as it does high into the millions and has increased in recent years at an alarming rate. That the full significance of this item may be realized it is shown below for the past 23 years with its relation to earnings.

	Loss and Damage			Loss and Damage	
Year	Amount	Per cent earnings	Year	Amount	Per cent earnings
1899	$5,976,082	.455	1912	$34,551,764	1.215
1900	7,055,622	.474	1913	39,638,222	1.268
1901	8,109,637	.510	1914	42,798,700	1.404
1902	11,034,686	.639	1915	37,947,468	1.284
1903	13,726,508	.722	1916	31,264,167	.903
1904	17,002,602	.861	1917	31,274,827	.850
1905	19,782,692	.950	1918	44,079,992	1.118
1906	21,086,219	.907	1919	66,300,736	1.334
1907	25,796,083	.996	1920	117,671,790	2.250
1908	35,046,170	1.464	1921	142,227,070	2.260
1909	33,330,751	1.378			
1910	30,984,854	1.127	Total	$847,083,821	
1911	34,397,279	1.233	(23 Years)		

The foregoing tabulation speaks for itself, approaching as it does the billion dollar mark.

To sum up we find quite an inviting field for the railway economist in questions of design, construction and operation. The problems to be attacked are as follows:

Rough treatment or abuse of freight cars	$171,100,038
Capital invested in excess bad order cars	119,001,000
Interest on investment	7,140,090
Estimated earning capacity	243,000,042
Loss and damage (1921)	142,227,070
Total	$682,468,240

And this does not include any charge for the use of tracks on which the excess bad order cars are stored awaiting repairs.

Divided Responsibility

The major portion of some of these items are beyond the power of railway managers to prevent, while others will yield to remedial measures. The excessive number of bad order cars awaiting repairs is largely in the former class, for which with a depleted or disorganized shop force it has been impossible to even make current repairs much less handle deferred maintenance. Loss and damage is a combined item much of it may properly be termed just a plain hold up game, against the carriers while there is enough of it chargeable to rough handling or abuse of equipment to justify a real wide awake campaign in that direction.

In the most highly developed and efficient organization there are sometimes found correspondingly weak spots, and our splendid railway organizations are no exception to this rule, as evidenced by the attitude of officers and employees toward the property in their charge. Some is guarded and protected with all the power at their command while the same persons by acts of omission or commission, contribute to or cause the neglect or damage to other property with impunity. Thus, if through a slight error of judgment, one of the oldest and most reliable train or enginemen should handle passenger equipment too roughly causing passengers to complain and possibly a slight repair expense to cars or engine, swift disciplinary measures would at once follow, while a yard or trainman new in the service, and frequently with no binding ties of responsibility, can with impunity regularly commit offences in the matter of rough treatment or destruction of property, thousands of times greater in money value, with not a word of censure. This double standard of dicipline is a *weak spot* in the operation of our railways, and while a complete remedy or cure may be beyond present expectations, yet great improvement can and should be made, as the result would at once be reflected in: (a) decrease in loss and damage claims; (b) decrease in cost of freight car maintenance; (c) decrease in number of bad order cars; (d) increase in average life of cars; (e) and in many ways contribute to a more highly efficient and economically operated transportation unit.

Effect on Design

In answer to the question, what effect will design have on these matters, the answer is plain and clear. The car has never been built which could not be damaged or destroyed through acts of omission or commission, and were it not for the wonderful progress already made freight cars of today would not begin to withstand the punishment to which they are regularly subjected in service, and by this same standard it may safely be said that if the coupler and draft gear committee will take vigorous hold of the latter feature, developing it up to the present state of the standard coupler it will result in saving great sums of money in damage to cars and contents, while of course it must be equally clear that many millions' saving may be effected through change or improvement in certain operating customs or practices that at present are unnecessarily expensive.

If the attitude of our railway officers in handling difficult problems in the past may be taken as a criterion of probable future action, then it may safely be assumed that along with other extra heavy burdens thrown on their shoulders during the past three years the foregoing questions of design, construction, operation and maintenance will receive their attention and it is safe to predict gratifying results.

Development and Installations of Automatic Train Control

By W. J. Eck

Signal and Electrical Superintendent, Southern Railway

The desirability of some form of control of railway trains to safely bring a train to a stop independently of the driver in case of conditions endangering the train was recognized in the very beginning of railroading.

No feasible method of accomplishing this result seemed possible, however, before the invention and general adoption of the power brake. The knowledge that the opening of the brake pipe line and the escape of the compressed air to the atmosphere would cause an application of the brakes was immediately recognized as affording a means of automatically stopping a train independently of the action of the engineer. All train control devices have been based on this property of the air brake system.

Many, in fact a majority of the inventors who have worked upon this problem have considered that the opening of a valve in the brake pipe line was all that is necessary for a successful train control system. It involves much more than this, however, particularly in the case of heavy freight trains. Of the hundreds of schemes that have been proposed from time to time—there are more than five thousand patents on file in the U. S. Patent Office on the subject—only about a score have been considered worthy of service tests and development under actual railroad operating conditions.

Many of the inventors had little or no knowledge of these conditions and their devices have little or no value; on the other hand many of the appliances have merit and a vast amount of intelligence and conscientious work has been done during the past thirty years. The results of this work are apparent in the devices that have been approved for test and are under actual development at the present time.

In 1888, Mr. Axel S. Vogt, of the Motive Power Department of the Pennsylvania Railroad, devised the first automatic stop used in this country. It was of the plain mechanical trip overhead contact type, consisting of an arm so mounted upon the signal mast that when the signal was in the "STOP" position the arm would intersect the path of a glass tube mounted on the locomotive cab. This tube was connected into the air brake system so that any attempt to pass the signal improperly would cause a fracture of the tube and the application of the brakes. With the signal in the proceed position the arm was removed from the path of the tube and the train could pass without hindrance.

Shortly after it was placed in service a tube was broken by icicles hanging from the roof of a tunnel and a passenger train was brought to a stop within the tunnel. The passengers were rescued only after some difficulty and no further installation of this device has been made upon steam-operated lines.

In 1891 the Rowell-Potter System, a mechanical trip contact, ground type, train stop was installed on the Boston Revere Beach & Lynn R. R. It was entirely mechanical in construction and operation, power being obtained by means of levers operated by the moving train and stored in coil springs. The same system was installed in 1893 on the Intramural Railway at the World's Fair at Chicago, and upon various other railroads, notably the Chicago, Milwaukee & St. Paul in 1902, and on the Chicago, Burlington & Quincy Railroad in 1908. The installations on the two steam roads just mentioned were of limited extent for test purposes and no extensions of the system were ever made. The device remained in service only a few months.

The first permanent installation of automatic stops so far as known was made on the Boston Elevated Railway in 1899. It is still in use and consists of a controlled mechanical trip ground contact worked in conjunction with electro-pneumatic block signals.

A similar installation was made on the Interborough Rapid Transit, New York, in 1903, also upon the Philadelphia Rapid Transit and the Hudson and Manhattan in 1908.

This device consists of a lever arm operated by compressed air in conjunction with the signal system so that the arm is raised above the track when the block is obstructed. This arm engages the handle of a valve in the brake pipe should a train attempt to pass a signal indicating "STOP." The opening of this valve causes the brakes to be applied.

A speed control feature devised by Mr. J. M. Waldron was added to the Interborough installation in 1912 which has materially increased the capacity of the road over that formerly existing with the plain automatic stop.

In 1910 the Washington Water Power Co. installed on 29 miles of a single track electric interurban line an automatic block signal system with automatic stops. The device installed was similar to that originally used on the Pennsylvania Railroad, viz., a glass tube mounted upon the top of the cars and positioned so as to be broken by an arm attached to the block signal in case the signal is passed improperly when in the stop position. As there are no tunnels or overhead structures on this line, its use here was not objectionable.

The Pennsylvania Railroad, in 1911, in connection with the terminal improvements undertaken by it upon entering the City of New York, installed a system of automatic stops to protect trains using the tunnels under the Hudson River and throughout the electrified zone extending to Manhattan Transfer, N. J. This automatic stop is of the mechanical trip type electrically controlled. The valve in the brake pipe and the trip upon the ground are of special design and so arranged that ordinary obstructions along the track will not operate the air valve. Ballast, snow, frozen mud, etc., will sometimes operate a valve of the design used in subways and thus interfere with traffic. In this case the ground trip is provided with a rotating member which raises the valve stem vertically when engaging and thus applying the brakes. It is shielded so that a horizontal blow will not affect the valve as is the case in the ordinary design.

The next installation of importance was one installed during the same year, 1911, by the Key Route at Oakland, California. This is an electric line and the device protects 34 miles of double track, an important part of this mileage being upon a three-mile pier which extends out in the bay to the terminus of the ferry boats from San Francisco.

The automatic stop consists of a mechanical trip over-

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head contact in the shape of a metal arm attached to the signal. This arm operates a valve handle on top of the cars when the signal is disregarded. The tripping of this valve results in a service application of the brakes and it can only be restored to its normal position by the motorman's brake controller after the automatic brake application has become effective.

In 1912 the Brooklyn Rapid Transit made an extensive installation similar to that in the subway in New York and that on the Boston Elevated Railway.

The next year, 1913, the Miller Train Control Company's intermittent electrical contact type automatic stop system was started on the Chicago & Eastern Illinois Railway. This was not only the first permanent, but up to the present time it is the most extensive installation on a steam railway in the world. It is now in service on a double track division between Danville and Dalton, Illinois, a distance of 107 miles.

An automatic application of the brake is effected when approaching a signal indicating "STOP" by means of a control valve and shoe carried by the engine engaging with a de-energized ramp. When the shoe comes in contact with a ramp it is raised and unless the electrically operated control valve is kept closed by current picked up from the ramp the engineer's brake lever is moved to give a service application of the brakes. An audible signal is sounded in the cab each time the engine passes a ramp. No speed control is used, although it can be provided if desired. A push button is provided so that the brake application can be forestalled at any time deemed necessary by the engineer.

There are 189 ramps, one of which is located braking distance from the signal at the entrance of each block. These are controlled by the indication of the signal and the condition of the block in advance. Only one ramp is used per block without preliminary or caution indication. Ramps are located on the right hand side of the track and govern in the direction of traffic. They are about 180 feet long, made of "T" iron with leg upward, and are supported on the ends of the ties so that the top of the ramp is 6 inches above the top of the running rail and 50¼ inches from the center line of the track.

The engine apparatus consists of two elements, a combined contact shoe and primary valve attached by insulated brackets to the engine frame or the forward right hand tender truck, and a control device in the cab which operates the engineer's brake valve. The shoe is of the vertical lifting type, adjustable to properly engage the ramp. The shoe assembly may be placed in an inoperative position when it is desired to move the engine over unequipped track.

The engine control consists of a cylinder in which is fitted a piston, the stem of which is attached to the engineer's brake valve. The piston is moved whenever the contact shoe engages a de-energized ramp, thus moving the brake valve handle to service position. There is no source of electrical energy on the engine and the engine circuit consists of but one wire between the contact shoe and the control valve. Roadside battery is connected to the magnet of the control valve through the ramp and contact shoe when passing an energized ramp.

The Chesapeake & Ohio Railway, in 1916 and 1917, undertook the next permanent installation on a steam-operated road in the United States by installing the American Train Control on 21 miles of single track between Charlottesville and Gordonsville, Va. An extension of this installation to Staunton, Va., a distance of 39 miles, is now being made and is practically ready for service at the present time.

In 1915 the American System was the subject of an experimental trial upon the Maryland and Pennsylvania Railway. It was then known as the Jones System and as such was tested by the Bureau of Safety of the I. C. C. The installation on the Chesapeake & Ohio, however, has been materially improved from the form originally tested and now consists of an intermittent electric contact system, the indications on the locomotive being picked up by the contact of shoes carried upon the locomotive with rails located parallel to the main running rails.

The engine apparatus consists of two contact shoes of the vertical lifting type attached by insulated brackets to the forward tender trucks, one on each side. An electromatic valve is operated through contacts on the spindle of the shoe so that when the shoe passes over a de-energized ramp it causes a brake application. A cab signal giving a clear and a caution indication by means of electric lights is also controlled by contacts on the shoe. A circuit reverser for transposing the circuits for backward operation of the engine, a battery and a reset key for releasing the apparatus from the ground after a brake application completes the equipment. Practically all of the locomotives operated in this territory are provided with this device.

In the original installation the ramps on the roadway are located in pairs in advance of the signal, one on each side of the track, the one on the right in the direction of traffic being used for the stop and the one on the left for the caution indication. The control circuits have been specially designed to meet local conditions and are a modification of those used in single track automatic block signaling.

The fixed signals along the roadway are of the light type, no semaphore arm being used, the day and the night indication both being given by colored lights.

Modifications of certain of the details of the apparatus have been made in the extension to the system about to be placed in service. These are partly to provide for alternating current operation of the automatic signal system and partly to take care of changes deemed desirable as the result of observations on the operation of the present installation.

The next installation in the United States in point of time was one made in 1918 by the United Railway & Electric Co., of Baltimore, Md. This is an electric road operating on the surface with two drawbridges and 150 trolley cars protected with an overhead mechanical trip device. It consists of a valve with an extended arm mounted upon the top of the cars where it will be struck by an extension from the signal if the stop indication is disregarded.

The Chicago, Rock Island & Pacific, in 1919, started the installation of an automatic train control system manufactured by the Regan Safety Devices Company, between Blue Island and Joliet, Ill., a distance of 22 miles. The device is of the intermittent electrical contact type with speed control. Ramps are installed along the right-of-way in connection with the three position upper quadrant signals already protecting the tracks in this territory. These ramps are 120 feet long and located 150 feet in rear of the signal; they are made of angle iron with a copper insert and mounted upon cast iron supports bolted to the cross ties. The ramps are insulated by means of wooden blocks from the iron supports and are connected into the signal circuit so that their removal will result in the signals displaying the stop indication.

The speed circuit controller consists of a centrifugal governor arranged to open and close a circuit at any predetermined speed. This governor is bolted to the end of one of the axles of the pony truck and the electrical connection to same is made by means of flexible conduit.

The electro-pneumatic valve operates in response to an electro-magnet and controls the brake pipe pressure and the reservoir supply to the engineer's brake valve. When the magnet is de-energized, the valve causes a service application of the brakes, this cannot be released by the engineer but he can further decrease the brake pipe pressure to apply the brakes in an emergency application. The shoe mechanism consists of a shoe stem and a circuit controller attached to the forward tender truck. The shoe picks up current from the ramp of the proper characteristic to actuate the locomotive apparatus and to control the train consistent with the indications displayed by the automatic block signals.

The system is designed to make an application of the brakes by the automatic control apparatus when any of the following conditions exist:

(A) When a train passes a signal in the caution position at an excessive speed.

(B) Whenever a train exceeds a predetermined speed while running in a caution block.

(C) At a stop signal, or when a block is occupied.

The Interstate Commerce Act of 1920 empowered the Interstate Commerce Commission to order the installation of automatic train stops or train control that would comply with the commission's specifications and requirements upon the lines of any carriers subject to the Act. To assist in carrying out the provisions of this act and at the request of the Commission a joint committee representing the various sections and divisions of the American Railway Association was appointed and started work in September, 1920. Specifications and requirements of automatic stops and train control were formulated, all existing installations investigated and arrangements were made with the New York Central and the Southern Pacific Railways for the installation of types of train control for tests purposes that have not heretofore been fully tried out under service conditions.

Upon the Southern Pacific, the National Safety Appliance Co. has installed between Haywood and Halveen, California, a distance of 4½ miles, a system of intermittent inductive train control. This system was tested by the Interstate Commerce Commission on the Western Pacific at Oroville, California, in 1919. Material improvements have been made recently and the system is now under observation by representatives of the Joint Committee.

A permanent magnet of laminated steel, located between the rails, is installed at each indication point. This is neutralized by a suitable coil energized by a roadside battery when the block is unobstructed. The locomotive apparatus consist of magnetic valves mounted under the tender in such a position as to come within the field of the track magnets. An air valve controlling the brake application is connected to the magnetic valve by suitable piping. No electrical energy is required on the engine.

In operation, the field of the permanent track magnet is normally in position to act on the engine magnets, neutralize their field and permit the attached valves to open and produce a stop by allowing the air valve to open the brake pipe to the atmosphere. If no stop is necessary, the neutralizing coil is energized and deflects the magnetic field of the track magnet to that it will not act on the engine magnets.

On the New York Central Railroad the tests are to be made upon the apparatus of the Sprague Safety Control & Signal Corporation.

The installation consists of equipment on one locomotive and about six miles of track in a very busy electrically operated section near New York City.

The system is of the intermittent non-contact induction type, with speed control, cab signals and a recording device. Electrical energy from storage batteries is used for neutralizing the normal danger track magnets when the block is clear. This is controlled by the relays of the wayside signal system so that the track magnets are not neutralized when the block is obstructed and by their influence upon the engine receiver cause the display of the proper signal in the cab and the applacation of the brakes.

Two brake application magnets are used in each block, one near the entrance and one at approximately braking distance from the stop signal. These, together with a reset magnet at the exit end of the block, as located between and some four or five inches below the top of the running rail. The engine equipment includes the receivers for picking up the magnetic impulse, the relays for translating the received impulses into action, the valve assembly for controlling and effecting the required brake application, the speed control mechanism and the cab signals. Other than the impulses received from the track magnets all electrical energy used on the engine is supplied by a storage battery charged by the headlight generator.

Various assemblages of the apparatus can be made to secure almost any desired control and operation.

The installation has been under observation for some months by the Joint Committee and official tests will probably be started within the next few days.

The Interstate Commerce Commission issued its now famous order No. 13413 on June 13, 1922, requiring automatic train stop or train control devices upon forty-nine carriers in the United States. Installation on one passenger locomotive division one each of the lines to be completed by January 1, 1925.

Largely on account of the strike of the railway shopmen starting of this work has been delayed so that few have been able to announce the type and character of the device to be used in compliance with the order. The matter is being actively handled at the present time and it is expected that work will be started at an early date on all of the lines specified.

The Pennsylvania and the Chicago & Northwestern have already announced that they will make an experimental installation of a practical nature, to determine the characteristics of the system selected by them and its performance under the various operating conditions met in railroad service previous to its installation on the very large scale required by the Interstate Commerce Commission.

The Pennsylvania Railroad now has under construction the automatic train control system developed by the Union Switch & Signal Co., and the Westinghouse Air Brake Co. The test installation will extend from about one mile from Lewistown, Pa., over a single track line for 45 miles to Selinsgrove Junction, thence over a double track to Sunbury, Pa., the latter portion being now equipped with A. C. track circuits and automatic position light signals. Wayside signals will be installed where not now in service, approximately one-half of which will be controlled by the train dispatcher at Sunbury and the other half of the single track line by a modified absolute permissive block system controlled by trains. The present manual block stations will be abandoned as block stations but will be used as reporting stations.

This system is unique in that it provides continuous control, all other installations of any material size being of the intermittent type; that is, the indication is transmitted to the train from the roadside apparatus only at definite points. The indication thus received continues as the controlling factor in the operation of the train until the next indication point is reached when it may be continued or changed, depending upon the indication there received. Continuous control systems, such as this, provide full speed control and transmit the indication to the cab of the locomotive at all times, thus giving immediate indication of any change in conditions in the same block or in the block ahead. This is effected by means of an alternating current circuit imposed upon the rails in addition to the usual track circuit. The circuit uses the two rails in parallel and is supplied through resistance coils from line wires. No ramps, magnets or other apparatus on the ground other than the regular running rails are required for conveying the indication to the train. Each engine is equipped with collecting coils positioned, one over each rail, storage battery, amplifying device, dynamotor, relays, speed control apparatus and brake operating valves.

The amplifying device consists of one or more vacuum tubes, such as those used in wireless telephone and telegraph work and they have the property of amplifying or increasing the small current picked up from the track by the collecting coils many times. This amplfied current operates the speed indicators and other apparatus on the engine.

The speed control apparatus consists of a centrifugal governor driven from an axle. It controls a series of valves primarily controlled by the electro-magnetic valves.

When the engine coil is passing over the track in the rear of a clear block its coils are influenced by the magnetic field around the rails, thus generating a small current which is strengthened by the amplifier until it is capable of energizing a three position relay. When a block preceding a stop signal is entered the polarity of the special track circuit is changed, which causes the display of a certain indication in the cab and enforces control of the speed through the brake apparatus. As the train proceeds it passes a point on the track between which point and the signal all current is cut off from the track. The induction relay is then de-energized, causing the brakes to be applied to bring the train to a stop at the signal.

The Chicago & Northwestern Railway has announced that contract has been signed with the General Railway Signal Company for an intensive test of their intermittent inductive train control with inert roadside elements. This system requires no energy on the roadway or physical contact between engine and roadway parts. The roadside element consists of a "U" shaped laminated iron core with a coil winding which may be opened and closed by the contacts on a relay in the signal system. The engine equipment includes a pair of coils mounted so as to pass directly over the track element, a storage battery, relays, an electro-pneumatic valve and means for applying a service application of the brakes through the engineer's regular brake valve.

When the signal is in the stop or caution position the coil on the track element is opened by the signal relay. In this condition the current normally flowing in the engine circuit is greatly reduced when the engine passes the indication point. This reduction in current causes the electro-pneumatic valve to operate and applies the brakes. It can be arranged, if desired, so that the application will not take place at the caution signal if the engineer acknowledges the signal by operating a lever, thus indicating that he has seen and understands the indication of the signal and will properly control his train. The acknowledging valve cannot be tied down to permanently cut out the device.

The speed control is obtained by determining the safe speed at any given point and locating two induction points on the road a corresponding time distance apart. If the train consumes less than this time going from one point to another showing that the speed is too high for that location the brakes will be automatically applied. If the train is going slower than the designated speed the brakes will not be set.

The systems that have been described include only the most prominent of those that have been installed on an extensive scale for regular service, in addition there have been many experimental trials of various devices made upon railroads of the United States, during the past thirty-four years. For the record I have compiled a list of some thirty-five of those that have come to the speaker's personal attention. It is no doubt incomplete. Some of the devices are no longer being advocated while the proprietors of others are quite active in their development.

Much, however, still remains to be done for there are yet many unsolved problems in the art of automatic train control.

AUTOMATIC STOP AND TRAIN CONTROL SYSTEMS TESTED ON AMERICAN RAILROADS

Name	Type	Where Tested	Year
Buell	Insulated truck	Southern Ry.	1906
Bulla	Ramp	E. P. & S. W. Ry.	1919
Clark	Inductive	Pere Marquette	1921
Clifford	Aux. track circuit	Erie	1922
Fox (A. H.)	Inductive	New York Central	1911
Finnigan (G. P.)	Inductive	I. R. T. Co.	1911
Gen. Saf. Appl. Co.	Ramp	Spokane Inland R. R.	1919
Gray-Thurber	Insulated truck	Penna. Lines	1911
Gollos	Ramp contact	C. G. W. Ry.	1912
General	Ramp contact	B. R. T.	1912
Harrington	Overhead trip	Erie	1908
Induction Sig. Co.	Inductive	N. Y. Central	1913
International	Mechanical trip	D. L. & W.	1912
Julian Beggs	Ramp contact	C. N. O. & T. P.	1916
Jones (D. C.)	Ramp contact	Southern Ry.	1910
Jones	Ramp contact	Maryland & Pa.	1913
Lacroix	Ramp contact	Staten Is. R. T	1911
M. V. All Weather	Inductive	Raritan R. R. R	1922
Nevins-Wallace	Mechanical trip	B. & M. R. R.	1919
Orcutt	Ramp contact	B. & A. R. R.	1919
Otis	Ramp	Canadian Pacific	1920
Patterson (H. D.)	Inductive	N. Y. Central	1909
Prentice's	Wireless	Canadian Pacific	1911
Ry. Auto. Saf. Appl. Co.	Mechanical trip	Pere Marquette	1911
Safety	Ramp contact	Hunting & B. T. M. R. R.	1912
Sanor & Conkell	Third Rail	W. & L. E. R. R.	1913
Shadle	Ramp contact	C. I. & W.	1919
Simmen	Ramp	A. T. & S. F	1908
Simplex	Insul. Engine wheels	B. R. & P. R. R.	1921
Schweyer	Inductive	P. & R. Ry.	1918
Sindebrand-Woticky	Track circuit	N. Y. C. & H. R. R.	1913
Stoigelmeyer	Ramp	Big Four	1909
Union	Ramp contact	D. L. & W.	1913
Warthen (H. J.)	Overhead trolley	B. R. & P.	1911
Webb	Ramp contact	Erie	1922
Wooding	Ramp contact	D. L. & W. R. R.	1916

N. Y. C. Locomotive 999 Not to be Scrapped

Locomotive 999 of the New York Central, which was exhibited at the World's Fair in Chicago in 1893, is to be preserved as a historical relic, and will be placed on exhibition at some prominent place, along with the DeWitt Clinton, of 1831. The "999" was built in the West Albany shops in 1892 and was designed by the late William Buchanan, for many years superintendent of motive power of the New York Central. Its well-known high speed records in 1893 were made by Charles Hogan, on the Empire State Express, on a run when the engine hauled the train through New York to Buffalo, 440 miles; and the best speeds were made in the last 70 miles. After service on the Empire State Express for a number of years, this engine was renumbered and relegated to more humble duty. In the summer of 1920 it was taken from its regular run on the Pennsylvania division and was restored to all its pristine glory with silver lettering to haul the DeWitt Clinton train to Chicago for exhibition at the Pageant of Progress. It is now stored at Utica awaiting the time when it will be placed on exhibition either at Grand Central Terminal, New York, or some other suitable place.

Mechanical Division Meeting of A. R. A.

The Mechanical Division of the American Railway Association will hold its annual meeting in Chicago, Ill., beginning Wednesday, June 20. Secretary V. R. Hawthorne expects to issue a detailed program in the next few weeks. The meeting will be continued through two or three days, depending on the business to be disposed of at the meeting.

New Patent Process to Recover Fuel from Slag and Ashes with the Aid of Magnets

By F. A. Brackmann

Various inventions have been brought out to recover the fuel contained in the slag and ashes on railways and at large industrial plants. The wet, floating system of separation was the first introduced, and several types have been placed on the market. These work on the principle that coke and slag have different specific gravities. The gravity varies according to the quality of the fuel, and to the degree of combustion. Sometimes there is hardly any difference in the gravity of slag and coke, and much of the latter sinks with the slag which causes considerable losses of fuel. Unburned coal also sinks and is removed with the slag. This not only constitutes a loss of fuel, but as the slag is extensively used in the manufacture of cement work, etc., and as any coal mixed with it disintegrates after a time, the latter is detrimental to the quality of the concrete. The working with water necessitates tempered rooms in winter, and other fluids when used require constant observation of their gravity, and some make it necessary to clean the product afterwards. These deficiencies of the wet process led to the introduction of dry magnetic separation.

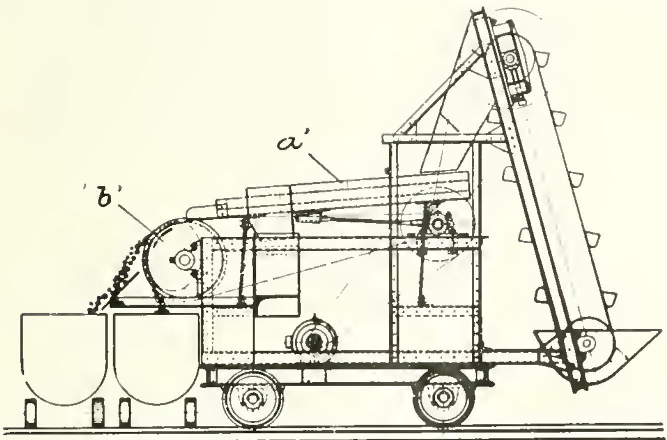

FIG. 1. MOVABLE PLANT FOR RECOVERING FUEL FROM SLAG AND ASHES

This system which is embodied in the patented plants recently put on the market by the German Krupp-Gruson works, makes use of the fact that the iron pyrites in the coal change into ferric oxide during the combustion. The magnetic properties of these oxides which are bound to the silicates and the lime in the slag make it possible to separate the latter from the combustible matters by subjecting the residues to the action of highly concentrated magnetic fields. The advantages have quickly been realized, and a large number of plants have been installed. Small coal, which is often contained in considerable quantity in the ashes is also recovered, which constitutes one of the main features of the magnetic system, and adds considerably to the economy effected.

Different trials and the results of separation plants working have shown, that more than 80 per cent of the combustible matter mixed with the slag may be recovered. The burning of the extracted fuel gives an efficiency from 70 to 80 per cent of the original coal. Naturally the amount of the coal and coke contained in the residues varies with the quality of the coal and with the system of the furnace. To save transport cost, smaller plants should be as close as possible to the place where the slag and ashes become available. The plants are therefore built in two types, movable and stationary, and in different sizes, with a working capacity of one-quarter to 20 tons of residues per hour.

They consist of comparatively few parts. At a large plant the residues are first tipped upon a grate of certain mesh. Pieces which are too large to fall through are broken up with a hammer or run through a crusher. From the grate they pass through a sifting drum, which separates them into two sizes. They are then passed to the separating machine where the slag on the one side, and coal and coke on the other side, fall into separate channels which may lead straight into cars or wagons below. Figure 1 shows a movable plant of the type used on the railways, with a working capacity of two tons per hour.

The separating machine is, of course, the principal part of every unit. The machine consists mainly of a shaking feeder "a," and a magnetic drum "b." Smaller plants are sometimes provided with an elevator to haul up the residues, and the grate and the sifting drum are substituted by a sieve which is fitted to the shaking feeder to separate the two sizes. Very large pieces are cast on to a moving band on the side, where they may be sorted by hand.

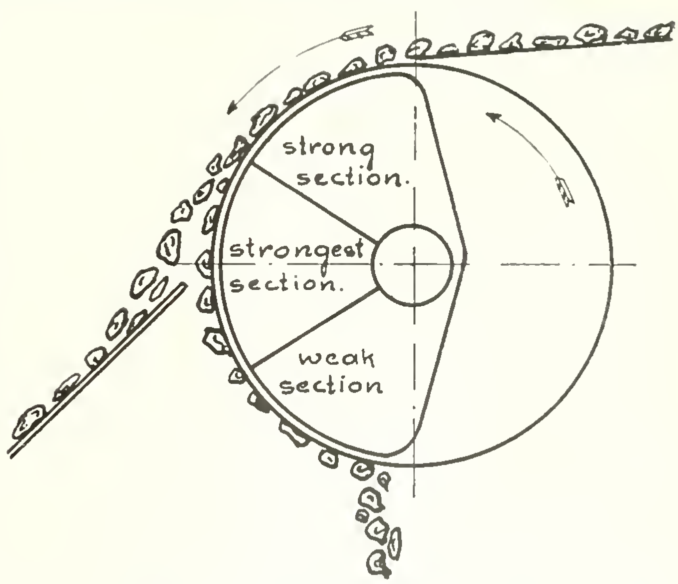

FIG. 2. MAGNETS FOR RECOVERING COAL FROM SLAG AND ASHES

The feeder delivers the residues on to the drum, Fig. 2, and the coal and coke, being non-magnetic, are thrown off, while the slag is held to it by the action of the magnet, until it is carried past an iron sheet, which keeps the fuel and the slag apart after separation.

The magnet, which is stationary inside the revolving drum, consists of one, two or four fields, according to the size of the machine. Corresponding to the number of fields, the feeder has two or four narrow channels leading in to the drum. Each field is divided into three sections. A strong one on the upper side, the strongest in the middle to counteract the centrifugal force, and a weaker section below which carries the slag to the lowest part of the drum, where it falls off. A drum of two fields separates about one ton per hour, and needs about one kilowatt of continuous current. The machines are generally built for a voltage of 110 or 220. A small separating plant working up 1 to 1.25 tons per hour requires about 1.5 h.p., a plant of 2 to 2.5 tons about 2 h.p., for the driving of the shaking feeder, the elevator and the revolving drum. The process promises to be an important factor in the efficiency of railways and industrial plants in the future.

Machines built on the same principles are also being used advantageously in the separation of slight magnetic ore as siderit, tungsten, limomite, red hematite, manganese, etc.

Australia's Chaotic Railway Gauges

Australia has 29,956 miles of railway of which 23,147 miles are owned by the Commonwealth and state governments. Each state has its own railway gauge. Victoria's is 5 feet 3 inches; that of New South Wales is 4 feet 8½ inches; of South Australia, part 5 feet 3 inches and part 3 feet 6 inches; the gauges of Western Australia, Queensland, and Tasmania are 3 feet 6 inches; and the Commonwealth line, which connects the systems of South Australia and Western Australia, is 4 feet 8½ inches, which is uniform with the gauge of neither state. To cross Australia from Brisbane to Perth one has to change cars six times, on account of change of gauge. A Royal Commission which has been investigating the feasibility of unifying the Australian railways has reported that complete unification will cost £57,200,000, approximately $278,000,000 at the normal rate of sterling-dollar exchange, and that to unify the main lines only will cost about £20,000,000.

According to a proposed plan, one-fifth of the cost of unification is to be borne by the Commonwealth and the remainder by the States on a population basis.

Despite the heavy price, Australia is determined to proceed with unification as soon as it is financially able to, and American manufacturers and exporters of railway construction material and rolling stock will do well to watch developments. Two of the Australian states have American railway commissioners, and though materials and rolling stock will be made in Australia as far as possible, the outlook for an important American participation in the unification work is good.

Samuel Vauclain Honored by Poland

Another signal honor was added to those already held by Samuel M. Vauclain, president of the Baldwin Locomotive Works, on January 18, when Hipolit Gliwic, counselor of the Polish Legation, as a token of his country's gratitude to Mr. Vauclain for his extraordinary services to the Polish cause, invested him with the cross and star of the Order of Polonia Restituta of the second class. There are five classes of this Order, and the second is the highest ever given. It is the highest honor that can be conferred by the Polish government and this is the first time that it has ever been given to a civilian. General Pershing and other high officers of the allied services hold the same decoration.

Mr. Vauclain through his speeches and otherwise rendered extraordinary service in the interest of the Polish Republic and also obtained for Poland credit for a large number of locomotives for that country that were ordered from the Baldwin Locomotive Works.

In addition to his recent signal honor Mr. Vauclain has been awarded the American Distinguished Service Medal. He is also a Commander of the Order of the Crown of Italy, and an officer and chevalier of the Legion of Honor.

Big Railway Projects in Spain

During 1923 the Madrid-Zaragoza-Alicante railway proposes to double the track and relay the section from Cordoba to Sevilla, a distance of 180 kilometers, with 45 kilo rails and to double the track and relay the rails on the lines from Port Bou to Barcelona, from Zaragoza to Madrid, and from Madrid to Sevilla, a total distance of 1,300 kilometers. Other projects reported to the Department of Commerce by Commercial Attache Cunningham include the construction of stations at Sevilla and Barcelona, and a station, roundhouse, and railway yards at Villaverde, near Madrid, the latter involving the expenditure of 25,000,000 pesetas ($17,250,000).

The Norte railway's plans for 1923 include the laying of a double track line from Palencia to Leon, a distance of 100 kilometers, and the electrification of the Pajares Pass. With this purpose in view, 50,000,000 pesetas in bonds ($7,750,000, at the rate for January 18), have been floated, and it is expected that this amount will be duplicated during the year. It is also expected that work will begin soon on the laying of 100 kilometers of double track from Valencia to Castellon.

Coupling Devices for South Australian Railways

An important market for coupling devices for South Australian railways may be opened in a few months. The use of heavier engines and heavier trains which the new American Railway Commissioner, who recently was placed in charge of State Railways, plans to introduce during 1923, will require a much stronger and up-to-date coupler than that now in use. As the couplings which will be required when the heavier trains are put into operation are not manufactured in Australia, American manufacturers may have an opportunity to obtain a share of this trade.

Electrification in France Proceeding

The Minister of Public Works has inaugurated the operation of electrical equipment on the railway from Pau to Tarbes. The actual electrification has been installed only from Pau to Lourdes. This section is operated from the station Coarraze-Nay.

The Minister of Public Works states, says Commercial Attache C. L. Jones, in a report to the Department of Commerce, that the southern railroad was committed to electrification of 3,000 kilometers of track at an early date, and that the Orleans and Paris-Lyons-Mediterranean Lines had each undertaken a similar promise. The director of the Midi Railroad states that the Line Pau-Tardes will be completely electrified by January 1, 1923; that the system will be extended to Montrejeau by March; and that during the summer of 1923 the Dax-Toulouse Line will be electrified.

It has been estimated that the substitution of electricity for steam on the railways will enable France to reduce her coal imports 3,000,000 tons per year.

A trial run of a French built electric locomotive was recently conducted by the French Ministry of Public Works. This locomotive is the first of a series of 50 which are to be built on a standardized design for railroad service between Dax and Toulouse, a distance of 220 miles. They will be constructed by the Societe des Construction Mecaniques, which recently established works at Tarbes where 900 men are now employed.

Decrease of Accidents Caused by Locomotives

The Eleventh Annual Report of the Chief Inspector of the Bureau of Locomotive Inspection of the Interstate Commerce Commission, and which is referred to elsewhere in this issue, shows that in the year ended June 30, 1922, there was a decrease of 113—or 15 per cent.—in the number of accidents caused by the failure of some part of a locomotive or tender, including the boiler. The 622 accidents which occurred in the fiscal year ended June 30 represented a decrease of 219—or 28 per cent.—compared with 1920.

The number killed by such accidents in the year ended June 30, last, was 33, a decrease of 48.4 per cent., compared with the 64 killed the year before, and a decrease of 51.3 per cent. compared with the 66 killed in 1920.

The number injured in the fiscal year ended June 30 was 709, a decrease of 11.3 per cent, compared with the 800 injured in 1921, and a decrease of 24 per cent. compared with the 916 injured in 1920.

An itemized table of these reports is as follows:

	Year ended June 30		
	1922	1921	1920
Number of accidents	622	735	843
Decrease from previous year, per cent	15.4	12.8	...
Number killed	33	64	66
Decrease from previous year, per cent	48.4	3	...
Number injured	709	800	916
Decrease from previous year, per cent	11.3	12.6	...

Railroad Taxes Trebled Since 1911

Within the past decade—that is from 1911 to 1921—taxes paid by the railways have trebled, according to the annual reports of the Interstate Commerce Commission. In 1911 the Class I railroads paid in local, state and federal government taxes $98,626,848 and in 1921, $275,882,150. In this ten-year period the total operating income of the Class I roads increased from approximately $2,752,000,000 to $5,516,000,000, or 100 per cent., while taxes increased 200 per cent.

In 1911 the taxes paid represented about 3½ per cent. of the total revenues of the Class I roads and about 11 per cent of the net operating income. The net operating revenue is that part of the total revenues which remains after the payment of operating expenses. In 1921 tax payments consumed 5 per cent of the total revenues and 28 per cent. of the net operating revenue.

Standard Box Cars

The Committee on Car Construction of the Mechanical Division of the American Railway Association has practically completed designs for standard box cars of 40 and 50 tons' capacity for submission at the next meeting. In the latter part of 1920 inside dimensions for box cars were adopted as follows: length, 40 ft. 6 in.; width, 8 ft. 6 in.; height (minimum), 8 ft. 6 in. With the length and width specified the maximum inside height that can be obtained within road clearances is 9 ft. 3 in. As the committee desires to show designs of cars that will meet the requirements and views of the majority of the railroads as to inside height and which can be used with a minimum of change, the American Railway Association has issued a circular requesting the member roads to vote for the height which they prefer. The circular explains that each additional inch of height above 8 ft. 6 in. will add approximately 70 lb. to the light weight of the car and will also add to the cost.

Locomotives and Cars Ordered in 1922

The number of freight cars actually installed in service or ordered for future delivery from car builders during the calendar year 1922 exceeded the previous year by 76,117 cars, according to the Car Service Division of the American Railway Association. During the past year 145,553 freight cars were installed or on order, compared with 69,436 during 1921.

Reports showed 77,221 freight cars actually placed in service in 1922 or 7,784 more than were both ordered and installed the year before. On January 1, last, unfilled orders called for the delivery of 68,332.

Reports also showed that in 1922 a total of 2,824 locomotives were actually installed or had been ordered from locomotive builders. This exceeded the number installed and on order during 1921 by 1,442.

During 1922, 1,379 locomotives were actually installed in service, only three less than the total number installed or on order the year before. On January 1 this year unfilled orders called for the delivery of 1,445 locomotives.

Railway Supply Manufacturers' Association

At a meeting of the Executive Committee of the Railway Supply Manufacturers' Association, held in New York, November 9, 1922, it was decided to postpone the 1923 R. S. M. A. exhibit. Such decision was reached following the announcement that Mechanical Division V, American Railway Association, would not hold a convention in 1923.

The decision of the Executive Committee of the R. S. M. A. was rendered after a thorough understanding as to the wishes of the various divisions of the American Railway Association, with which the R. S. M. A. has been associated.

The R. S. M. A. Executive Committee understands that it is the plan of Section V and Section VI, American Railway Association, to hold strictly business meetings during 1923.

It is, therefore, announced that as an association the Railway Supply Manufacturers' Association will not take part in any exhibit to be held in connection with railway meetings during the year of 1923.

Applications of the Nicholson Thermic Syphon

That the Nicholson Thermic Syphon is being recognized as one of the most important improvements in locomotive construction of recent times is indicated by the fact that in the last few months 247 installations have been ordered for locomotives by the following roads: Chicago, Rock Island & Pacific, 30 Mikados and 10 Mountain; Erie, 40 Mikados and 20 Pacifics; Illinois Central, 75 Mikados and 10 old engines; Central of Georgia, 10 Mikados; Nashville, Chattanooga & St. Louis, 12 Mikados; Atchison, Topeka & Santa Fe, 2 Mountain, 2 Pacific and 2 Santa Fe's; Baltimore & Ohio, 25 Consolidations; Temiskaming & Northern Ontario, 6 Ten-Wheelers; Lake Superior & Ishpeming, 3 Ten-Wheelers.

The science of this economical feature of locomotive design was the subject of an article by Mr. C. A. Seley, Consulting engineer of the Locomotive Firebox Company, which appeared in our issue for January.

Railway and Locomotive Engineering

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The Railway Situation

There prevails in America much unintelligent thinking about the railways. There is the persistent cry for better service and more efficient operation. There is the tenacious demand for continued high wages—even higher wages—and for less work, while every shipper and traveler in the land wants reduced rates and fares. There is deplorable disregard of railway indispensibleness, widespread misunderstanding of railway economics, and uncanny belief that the railways may be milked perpetually without adequate feeding.

The Era of Railroad Decline

When the evils of early railroading were exposed to public view there arose a hue and cry against all railway interests, and the prejudice was fanned into intense hatred by leadership of reforming seekers of political power. Discriminations were prohibited by law, which, very likely, was heartily approved by all wise managers, as thereby were revenues increased. But public indignation was not permitted to abate and curbing statutes were enacted which stifled railroad development.

Conditions went from bad to worse. Public confidence in railroad securities was destroyed. Conflicting regulatory bodies harassed transportation, reduced the income to a dangerous extent, and minimized the initiative of those charged with operating responsibilities. Thus, with credit impaired, with insufficient trackage, terminals and rolling stock, and without credit, the railroads faced the extraordinary strains of the World's War, and the Government was forced into the railroad business in order to do identically that which private owners had been prohibited from doing.

Government Operations

During the period of government operation a new order was instituted. Wages were raised again and again. Working rules and conditions were established which minimized managerial control. Rates and fares were elevated, but not in proportion to the advanced cost of conducting business. Traffic and travel were diverted from their natural channels, and the machinery of transportation was disjointed in many places.

The wear and tear of war, the waste and destruction of war-time business, the addition of multitudes to railroad payrolls, the confusion, disorganization and lack of maintenance, depleted and emaciated the systems of transportation. The experiment cost the people billions of dollars in taxation, but it taught them the utter folly of politically operating business enterprise in which large bodies of men are employed.

Private Operation Again

Then came the era of positive regulation. The roads were thrown into the laps of their owners, but not in efficient working condition, as the disorganizing practices and the deficiencies of equipment continued. The deliverance was effected by the Esch-Cummins Act, which in general principle is wise, but unwise in many details because of compromises. The Interstate Commerce Commission was charged with the duty of establishing such rates as might yield to average efficiently managed roads of reasonable compensation based on the value of property held for and in transportation. The Labor Board was granted power to consider and adjudicate differences of opinion regarding wages and working conditions, but without power to enforce its decisions. One regulatory body virtually controls income, another body expenses, as labor consumes from 50 per cent to 60 per cent of the gross revenue.

Divergency of responsibility and lack of power to enforce decisions were the causes of confusion, misunderstanding and resistance. The chaos was aggravated by labor's refusal to recede from the advantages forced from political directors during war emergency. That was very natural and not censurable. Every man was quite willing to let the other fellow do the deflating, but that was poor economics just the same. When the whole country was liquidating railroad rates and wages were reduced. The shopmen's strike was called to resist that wage cut ordered by the Labor Board a judicial body without power to enforce its decisions. The cost of that strike and the contemporary coal strike materially delayed railroad rejuvenation and temporarily divorced public confidence because of subsequent poor earning statements.

Present Difficulties

There are many aches and pains in the railroad body which must be cured. The late shopmen's strike emphasizes the need of power to enforce carefully weighed decisions in labor disputes. That strike was enormously expensive to everybody and benefited no one. Idle men lost heavily; owners of property lost more heavily; the American public lost more heavily. Safe, uninterrupted, continuous rapid shipment and travel are fundamental necessities, especially in the era of small margins of profit which we seem to face. Strikes are intolerable economic insurrections akin to wars. Means of judicially determining the right and justice in labor disputes and the enforcement of weighed decisions are imperative.

Billions of dollars of the people's money have been used of late in the construction of highways and the not yet appreciable cost of maintaining such structures may be enormous. The highways have been located by discreet public men as separate and distinct economic units. They have been constructed between congested centers rather than into more remote regions. They encourage motor competition with the railroads rather than broadening the scope and facilities of general transportation. Enormous tonnages of freight now move by truck which, with equal or better economy, should move by rail. Thus, many highways paralleling the railroads consume the people's money in duplicated transportation facilities, add to the tax burden for road construction and maintenance, and decrease railroad revenue, railroad credit, and railroad power to serve the people. Highway construction and railroad operation should be co-ordinated, one to augment the other, both to minimize the cost and maximize the happiness of living.

The operation of many independent lines of railroad is intolerably expensive and necessitates much avoidable delay in shipment and travel. The railroads are essentially monopolistic under the present system of positive regulation. Hence, the process of consolidation, which developed high efficiency in the former American carriers, should be resumed, as provided in the Esch-Cummins Act. Moreover, the hands of those charged with railroad responsibility should be freed from red tape and ulterior interference with the execution of policies promulgated by the Government. There is no possibility of maximum efficiency until that is done.

These problems concern the welfare of the people more vitally than one out of every hundred citizens comprehends. It is folly to think the railroads may be abused and buffeted about and deliver that efficient public service which must be had for the rapidly growing and spreading industrial enterprises of the country. It is time to think rationally about these matters, and that being done by the best brains of the nation.

Value of Statistics in Railway Operation

The value of statistics in the study of railway operation was the subject of an address delivered by Sir William Acworth at the Institute of Transport, London, England, and while it is true that statistics may be and often are misread or misapplied, they are if properly scrutinized an infallible guide in detecting weak points in organization.

Taking the facts disclosed by statistics of the working of railways in the United Kingdom, Sir William Acworth exposed many fallacies that exist in regard to such subjects as average length of haul and average freight train load. These statistics proved that the average length of haul in Great Britain is about fifty-eight miles, which is the same as that on German railways, and that it is almost impossible to make a comparison which would justify the statement so frequently made, that British railway rates are the highest in the world. The average freight train load in England is now 135 tons, which is considerably below the figure assumed by those who hold this theory. Sir William Acworth contended that British railways judged on an international basis, ought not to be congested with traffic, as the tonnage per route mile is only 900,000 tons a year, which is far below that of the United States, which is 1,650,000 tons; of Germany, which is 1,000,000 tons and very little above that of the narrow gauge railways in Japan. Although British railways have a much larger percentage of double track than other countries, congestion is more apparent on them than elsewhere by pointing out that the small average freight train load is the main cause of congestion.

Sir William Acworth went on to say that one reason for the comparatively small average trainload of 130 tons in Great Britain compared with 650 tons in the United States, 225 tons in Germany and 400 tons in Canada, is the retention to such a large extent in English railway working of small capacity cars. The British average is 10.24 tons per car compared with 42 tons on American railways. It has so often been said in the past, that the low average train load is explained by the fact that the speeds of English freight trains are much higher than those of foreign countries. The statistics show that, whereas for the first six months of the past year freight train speeds in the United States averaged 11.7 miles per hour, the English average for the month of May last was 9½ miles per hour.

A Complicated Labor Situation

A court action involving a number of points that are without precedent came to a hearing in the United States District Court in Chicago on January 22. In it there were five parties in interest involved: the United States Railroad Labor Board; the National Union of Railroad Shopcrafts Workers; the Big Four Railroad; the contractors who are engaged in the operation of the Beech Grove shops of the railroad company and the Associated Employes of Beech Grove, Inc.

It is a test case to decide the right of a railroad company to contract for the execution of its repair work with outside parties. The Labor Board has ruled that such action by a railroad was illegal and contrary to the Transportation Act, in that it removed the employes from the jurisdiction of the Board.

The Beech Grove repair shops were taken over by a contracting company, the Railway Service and Supply Co., about a year ago. Piece work was restored by them, while the shopcrafts union favored the retention of the hourly wage system that had been established by the Federal administration.

Then in order to put themselves in a position to be recognized by the Labor Board the employes of the shops, organized into a body, and were incorporated under the laws of Indiana by which the organization assumed full responsibility for their acts, and one of their acts was to endorse the return to piecework.

The court action was instituted by the Railway Service and Supply Company in a petition asking for a writ of certiorari to review the action of the Labor Board declaring its contract null and void. This petition was followed by a similar petition of the Associated Employes of Beech Grove, Inc., seeking the same relief, on the ground that their rights of employment had been invaded. The court on its own action then required the shopcrafts union and the railroad company to appear.

The employes and employers are acting in concert in the case, both declaring their present relations are satisfactory and should not be disturbed.

The men at work claim that they are making greater earnings than they would under the Labor Board regulations and the railroad company insists that the arrangement enables it to have its equipment repaired at lesser cost.

The situation is certainly one of interest and one in which the equity of the case would seem to show that the rights of the interested parties have been invaded. We have here these three interested parties declaring that they are satisfied with the present arrangements and that they are to be preferred to the arbitrary hourly wage set up by the shop crafts.

The Labor Board as a board of arbitration ought to have no interest in the matter, because the interested parties have no grievance, they are quite satisfied and simply ask to be let alone.

The shop crafts are interested solely because a certain section of the community has been removed from their sphere of influence by its own voluntary act. It is to retain power over these seceding members that it acts. At least there does not seem to be any other plausible motive for interference. It is hardly probable that the court will declare an agreement null and void when all the parties to it wish to have it sustained.

It All Depends on Whose Ox Is Gored

To one who recalls the unwarranted, and frequently malicious attacks on railways some years ago with respect to loss of life, and the silence now on that particular subject might, in the absence of inquiry lead to the conclusion that, the railways having been properly disciplined by these wonderful reformers, thus removing all danger to United States citizens when at their usual avocation, the heavy artillery can now be trained on economic questions pertaining to railway affairs.

A very slight search of the records however, reveals the fact well known to many for more than 25 years, that the great majority of those who railed so loudly against the railways, particularly accusing them of wilfully slaughtering people, where not so much interested in protecting the American peoples' lives, as they were in trying to find some ground on which to attack railway interests and poison the public mind against them, and that they made great progress in that direction is well attested by the tremendous cost to the railways, to in a measure offset this insidious propaganda.

As proof of the absolute insincerity of most of the loudest mouthed leaders in this campaign, some figures are presented herewith in tabulated form which speak volumes on the subject, but may be more clear to some, if commented upon to bring out certain fundamental features.

The wonderful improvement in the standard of discipline among the working forces of our railways since the roads were returned to their owners is clearly reflected in the following tabulations:

	Killed by Automobiles With Increased Per Cent and Ratio			Killed on Railways With Decreased Per Cent and Ratio			Range of Difference in Per Cent,
Year	Number Killed	Increase Over 1914	Per 100,000	Number Killed	Decrease Over 1914	Per 100,000	In.—Dec.
1914	4,231	...	4.2	10,302	.....	10.3	...
1915	5,928	40%	5 9	8,621	.16%	8.6	56
1916	7,397	74%	7.3	9,364	.09%	9.3	83
1917	9,184	117%	9.1	10 001	.03%	10.	120
1918	9,672	128%	9.6	10,087	.02%	10.	130
1919	9,827	132%	9 8	9,286	.09%	9.2	141
1920	12,000	183%	12.	6,978	.32%	6.9	215
1921	13 200	211%	13.2	6,958	.32%	6.9	243
1922	14,520	242%	14 5	5,996	.41%	5.9	283
Totals	85,669	....	....	77,593	.....	....	...

Of the 5,996 killed on railways in 1921, 2,481 were trespassers, and by eliminating these we have 3.55 or 3.5 to each 100,000, while in ten of the principal cities of the United States there were killed by automobiles in 1920 from 17.1 to 24.1 persons to each 100,000, or an average of 18.61, yet in the face of this slaughter of its citizens, much of it by persons who should have never been allowed to drive a car, the great army of reformers and calamity howlers who so openly condemned the railways a short while ago, in a pretended defense of the people, are now painfully silent, when if there was any truth, or an atom of sincerity in their former declarations, vigorous action would be in evidence from all sources at the present time.

In ten cities of the United States more than 2,500 persons were killed in one year by automobiles while there were less than 2,500 killed on the railways of twelve European countries, which included among others Spain, France, Italy, Sweden, Belgium, Holland, Switzerland and Austria.

Railway Men Highly Trained

It is awell known fact to all who are reasonably well informed that the railway men in the United States are among the best disciplined in any line of human activity, and that the locomotive engineers are without exception men, who have stood the acid test as it were, through a long course of apprenticeship and are what may be termed, men of reliability, or seasoned timber, while thousands of automobiles are daily in the hands of inexperienced, incompetent operators, while not infrequently middle aged or old people are killed by automobiles driven at reckless speeds by mere children, yet in face of all this we hear little or nothing in the way of any constructive campaign to arrest or stop this evil and why! Simply because the automobiles as a rule, are private property, owned by individuals while the railways represent corporate interests, and the public have been taught that the latter are their common prey, through courts, juries, and th activities of damage suit lawyers, some of whom are rather unscrupulous in their methods.

Dangerous and Destructive Agencies to Human Life

The latest reports of the number of locomotives and automobiles in this country are as follows:

Description	Total Number	In the Hands of
Locomotives	66,721	Experienced, competent, reliable men.
Autos and trucks....	12,281,455	Some competent and reliable, thousands wholly unfit, including women and children.

The wonderful reductions made in the loss of life, and loss and damage to property on our railways has been due to the combined effect of the "Safety First" slogan so persistently followed up by the railway officers, and the elimination of harmful influence of Government Control on the rank and file, while the almost painful silence of those, who if consistent, should be more active against automobile fatalities than they were against railways, proves that it makes a great difference as to whose ox is gored, for the prospects of monetary returns or financial gain is much greater when suing a corporation than in suing an individual.

There are about one and three-quarter million railway employes in this country who should make it their business to see that the public is correctly informed on this and other related subjects, by talking to the editors and publishers of papers and other periodicals, County, Municipal, State and National officers, the clergy and their neighbors, to the end that no one may plead lack of the true facts or be allowed to escape their responsibility by act of either omission or commission.

Review of Locomotive Conditions in 1922

The condition of the locomotive equipment of the Class I railroads for the year 1922 up to December 1, is seen in a review of the reports of the Interstate Commerce Commission and the American Railway Association for that period.

On January 1 last year 15,383, or 23.8 per cent of the locomotives were in need of repairs. This percentage during the next four months increased, and then decreased, and on July 1 14,412 locomotives, or 22.4 per cent, were unserviceable. The number requiring repairs thereafter increased as a result of the shopmen's strike, until September 15, when the peak was reached, and 20,157 cars, or 31.4 per cent, were in need of repairs.

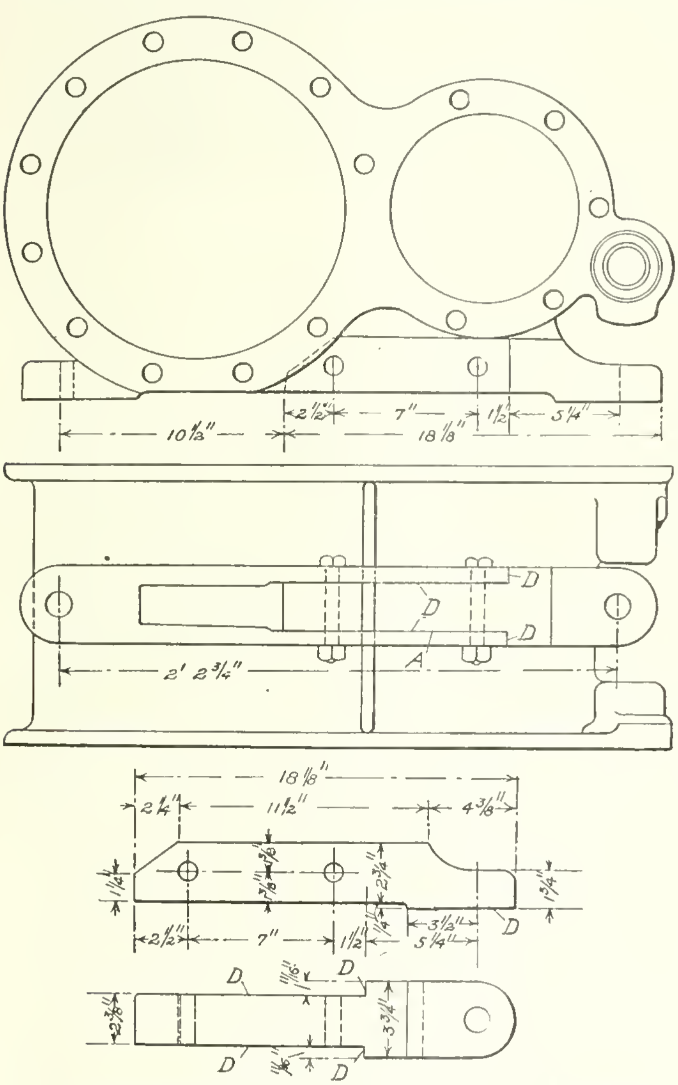
Thereafter conditions improved rapidly and on December 1 the number had been reduced to 18,009, or 27.9 per cent.

Railway Shop Kinks

Some Special Devices Used for Repairing and Maintaining Air Brake Equipment

Method of Repairing Broken Lugs on Air Pumps

The method of repairing broken lugs on air pumps on a very prominent railway is to forge and finish a piece of wrought iron or open hearth steel to the shape given in the detail at the bottom of the engraving. In this the dimensions are given for an 8½ in. cross compound pump and can be varied to meet the requirements of one of another size. The piece is finished as indicated at D.



DEVICE FOR REPAIRING BROKEN LUGS OF AIR COMPRESSORS

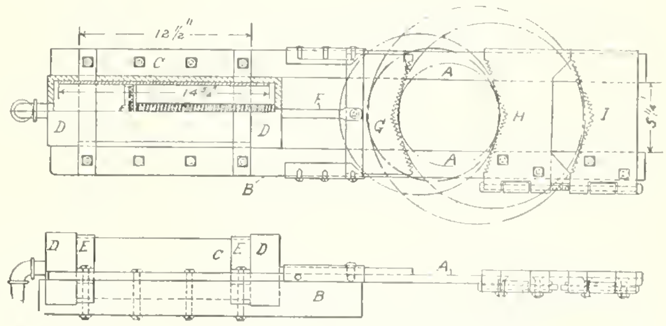
The recessed portion of the foot or lug is then cut away and finished as shown at *A* on the side elevation forming a fork into which the finished forging is fitted. Two holes of 25/32 in. diameter are then drilled through the foot of the lug and the repair piece and the two firmly bolted together by finished bolts, as shown. The bearing face of the repair piece is then finished to be in line with the corresponding foot on the unbroken side of the pump. With this method of repairing the pump it is as rigid and firm in its fastenings as a new machine.

Pneumatic Device for Holding Brake Cylinder Pistons

It is frequently necessary to hold brake cylinder pistons for repair work such as the replacing of the packing leather, cleaning and refitting. The pneumatic device, here illustrated, constitutes a very simple arrangement for doing this.

There are two flat plate *A*, made of 2 in. by ⅝ in. steel, which are bolted, at one end, to a table *B*, the upper portion of which only is shown.

A cylinder, *C*, made of a piece of 4-in. wrought iron,



PNEUMATIC DEVICE FOR HOLDING BRAKE CYLINDER PISTONS

which is closed by the caps *D*, is held to the plates by the clamps *E*.

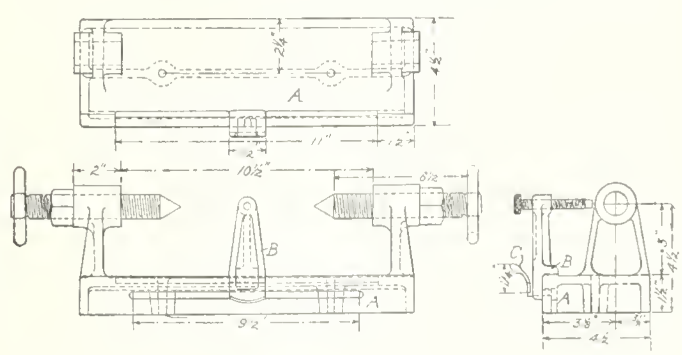
A single-acting piston with the usual cup leather packing, is fitted to this cylinder, with a piston rod *F* extending out from the right hand side and connected to a crosshead *G*, which is fitted with a V-shaped engaging face which, with the dead block *H*, forms an effective chuck for holding the work.

This dead block is bolted to the flat bars and is in two pieces. When large pistons are to be held only the single main back piece, *I*, is used. But when it is necessary to hold the smaller sizes, the filling piece *H* is inserted.

Compressed air is admitted to the left hand end of the cylinder through a ½-in. supply pipe, and it is controlled by a three-way cock. The retraction of the piston to the release position is effected by means of a light helical spring about the piston rod, with a bearing against the piston and the right hand head.

Centering Device for Triple Piston Valves

As is indicated by its name, this is a small bench tool for centering the piston valves of triple valves. It consists of a light bedplate *A* 14-in. long with an upright at each end for carrying the centering screws, each of which



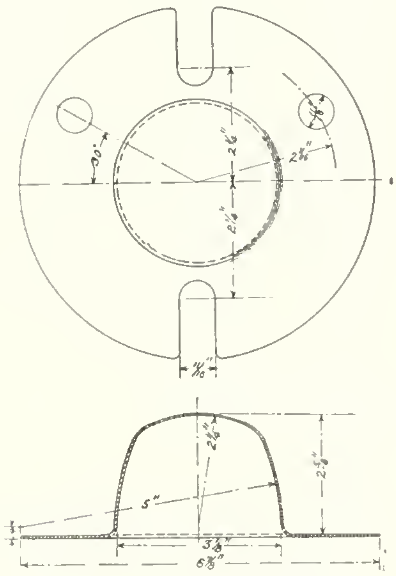
CENTERING DEVICE FOR TRIPLE PISTON VALVES

is furnished with a handwheel and a lock nut. Sliding along the front face of the bedplate is the post *B*, which may be locked in any position by the friction lock handle

C. Then in the top of the post there is an adjusting screw by which any inequalities or variation in the valves may be measured. The device is light enough to be readily carried about, or may be fastened to a bench.

Triple Valve Protection

In order to protect triple valves from the intrusion of dust while in storage or in transit a pressed steel shield is in use. It is made of steel 1/16 in. thick and is drilled to



TRIPLE VALVE PROTECTOR

match the holes in the flange. The dimensions are given on the engraving.

Triple Valve Seat Facing Files

A set of files has been designed for facing the valve seats of triple valves. Their outstanding peculiarity is the

File No.	Dimensions in Inches			
	A	B	C	D
1	1 9/16	1 7/16	9 1/4	4 1/2
2	1 1/4	1 1/8	9 1/4	4 1/2
3	1 1/16	1	9	4 1/2
4	1	15/16	9	4 1/2
5	59/64	37/64	9	4 1/2
6	55/64	53/64	9	4 1/2
7	51/64	49/64	9	4 1/2
8	36/64	33/64	9	4 1/2

TRIPLE VALVE SEAT FACING FILES

handle of the dimension *D* at the opposite end from the tang. The files are square with a very fine double cut. It is also specified that they must have absolutely true cutting faces. With this and the handle, a man can exert an even pressure and cut over the whole surface of the seat.

There are eight in the set and the dimensions of each one are given in the accompanying table and they are intended for the following uses:

No. 1 is for the equalizing slide valve of the U. C. valve;

No. 2 is for the release slide valve of the U. C. valve;

No. 3 is for the emergency slide valve of the U. C. valve and the K2 valve;

No. 4 is for the distributing valve complete of the F29 triple valve;

No. 5 is for the K1, F27, H49, K3, K6, New York triple valves;

No. 6 is for the H1, F1, and G. N. 1 New York triple valves;

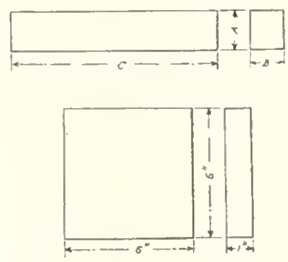
No. 7 is for the H1 and F36 triple valves.

No. 8 is for the B3, B4, C6 and B6 feed valves.

The dimension *B*, or thickness between the the two cutting facs, which are 1 and 1, is an approximate dimension only.

Face Plate for Refacing Valve Seats of Triple Valves

The accompanying engravings give the dimensions of a set of parallel strips and a square face plate that have been developed for refacing valve seats of triple valves. The parallel strips are of such dimensions that they can be set down on the seats and rubbed. In the case of the parallel strips the four long faces are the ones that are given the fine finish and which must be absolutely true. With the square face plate it is the two opposite faces 6 in. square that are so finished.



Parallel Strip No.	Dimensions in Inches		
	A	B	C
1	1 9/16	1 1/4	8
2	1 1/16	59/64	8
3	1	55/64	7
4	59/64	36/64	6

SEATS FOR REPAIRING FACE PLATES OF TRIPLE VALVES

There are four parallel strips in a set having the dimensions set forth in the accompanying table, and they are intended for the following purposes:

No. 1 is for the equalizing and release slide valve seat of the U. C. valve;

No. 2 is for the emergency slide valve of the U. C. valve and for the K2, K1, F27, H49, K3 and K6 New York Triple valves;

No. 3 is for the No. 6 distributing valve complete and for the H1, F1, GN1, New York triple valves.

No. is for the H1 and E36 triple valves, and for the 2B3, B4, C6 and 2B6 feed valves.

Pennsylvania's New Locomotive Equipment

Last month the Pennsylvania announced the placing of orders for 300 locomotives to be constructed and delivered during the present year. Of the total number, 125 will be constructed at the Company's Altoona Works. These will consist of 42 heavy passenger engines, 40 medium weight passenger engines and 43 switching engines.

The remainder of the authorization covers 175 heavy freight engines. Arrangements for the construction of 100 of these have been made with the Baldwin Locomotive Works, Philadelphia. The allotment of the other 75 will be determined later.

Results of Water Treatment on the Missouri Pacific

A paper presented before the Western Society of Engineers

By W. C. Smith

Mechanical Superintendent, Missouri Pacific Railroad

The experience of the past year has proven clearly and unquestionably the great advantage to railroads in giving careful attention to the quality of locomotive boiler water supply. It is recognized that the question of proper water supply is an individual problem in each instance. On the Missouri Pacific after experience with many varieties of proprietary compounds and also soda ash, the definite policy for a constructive program of improvement of the poor quality of water supply by elimination of the largest possible amount of impurities before giving water to locomotives, was put into effect and has been consistently followed with very satisfactory results. In reporting these experiences, it is not intended to offer recommendations for universal practice, but the data are submitted as information, and it is probable that they may prove of benefit in suggesting a method which has effected large economy and materially assisted in the improvement of locomotive operation and maintenance.

The Missouri Pacific system operates approximately 7,500 miles of railroad. It taps nine states extending from the Mississippi west through the plains of western Kansas to the Rocky mountains, and from the Missouri river south through the Ozarks of Arkansas and the bayous of Louisiana. The characteristics of the water supplies sources vary from the best to among the worst in the country. Water supply problems include the handling of the coal mine waters in Illinois, the muddy waters of the Missouri, the gypsum and alkali waters of the Kansas plains, the salt waters from oil fields, and the soft soda waters from southern deep wells.

With such variety in quality of water supplies the marked difference in effect upon engine performance and operation was early noticed. Trouble from scale with consequent leaking and short life of flues and fire boxes on bad water districts was a problem of the first importance. Various compounds and soda ash were tried out as internal treatments, but in most cases the increase in foaming tendency was so aggravated together with the expense and difficulty of a careful follow up system, that it was decided by the management to place reliance upon the development of more careful and reliable methods.

Complete water softening plants were first installed in 1905. The terminals at Little Rock, Kansas City, Hoisington, Wichita and Pueblo were equipped and a number of intermediate stations between Poplar Bluff and St. Louis, St. Louis and Bush, Ill., also between Kansas City and Pueblo, about 32 stations in all. A summary for the year 1909 developed the following: Water treated, 312,234,000 gallons; scale removed, 591,000 pounds. Compared to 1905, there was a 44.7 per cent reduction in engine failures due to leaky flues, etc., and also a reduction of 33.3 per cent in boiler maintenance and consequent increase in net tons handled per mile.

In view of these results and the large return on the investment, appropriation was made for eighteen additional plants to be installed in the bad water district west of Kansas City. Up to this time the entire supervision for all plants had been located in St. Louis, but it was found that the distance was a severe handicap in securing efficient and regular results, so that in 1910 small laboratories were established and a traveling chemist located at Kansas City and Little Rock, these being central and convenient headquarters. This arrangement worked out very well and excellent results were obtained.

Present Practice on the Missouri Pacific

In 1917 eight additional plants were installed on the district between Hoisington, Kansas, and Pueblo, Colo., which completed the treating equipment at all water stations on this territory. The results obtained were so definite and satisfactory that the district from Kansas City to Omaha was similarly equipped in 1919 and 1920. Since that year the development has been steadily continuing until there are now, including nine soda ash plants, 81 softening plants in service, and six additional under construction. Of the total of 81 softening plants in service, 36 are of the intermittent type and 45 of the continuous type. Hydrated lime and soda ash were used for the removal of objectionable matter in supplies, except at the nine soda ash plants where treatment consists only in the removal of the incrusting sulphates.

In the intermittent type of softening plants, at least two tanks are necessary in order to furnish a constant supply of softened water for use, the treatment being intermittent, one tank being in progress of filling and treatment while supply is being used from the other. In the continuous type of plant but one tank is necessary as the chemical solution is fed proportionately with the raw water, thereby furnishing a continuous supply of softened water. It is not the purpose of this paper to give a lengthy discussion of the various features and details of construction nor the relative merits of the two types of plants, either one of which when properly designed, constructed and operated will furnish a softened water of the desired quality.

The cost of chemicals used in treatment varies from 1.2 to 13.3 cents per thousand gallons depending on the quality of the raw water. An average cost is approximately 4 cents. The total average cost of treatment, including cost of chemicals, operation of plant, depreciation and supervision is approximately nine cents per thousand gallons. Installation costs for plants will vary over a considerable range, from $75 cost for conversion of roadside tank into soda ash plant, to $22,000, cost of some of the patented softening plants now on the market. An average cost for installation in use on this system is approximately $4,000.

With the installation of six or eight more plants at some of the points of greatest consumption, it is expected that the water supply quality on the Missouri Pacific will be very well in hand. Statistics for 1922 will show that there are 387 water stations in service. Approximately seven billion gallons are supplied per year, of which six billion gallons are used for steam purposes. Of this amount 2,400,000,000 was softened and approximately 5,000,000 pounds of scale removed which would otherwise have gone into the boilers, causing scale and its attendant troubles. It is estimated that a saving of 70,000 tons of coal was effected in 1922 by keeping this insulating coating from forming on the tubes and sheets. The saving in boiler maintenance, engine time and from engine failures has also been very large. It is estimated that a net saving, after subtracting the cost of treatment will be in the neighborhood of $500,000, although the investment in treating facilities does not exceed $300,000. The intangible benefits such as the improved morale of the forces and the greater reliability of the power are factors which have also benefited greatly by these facilities but cannot be reduced to dollars and cents.

Results of Water Treatment in Reducing Maintenance Expense

An interesting feature was brought out on the Colorado Division which runs from Hoisington, Kansas to Pueblo, Colo., 338 miles and is divided into two engine districts at Horace. Before water treatment it was necessary to take out a "V" of flues every four to six months and clean out the scale, and then renew the entire set after ten or twelve months' service. The flues in locomotive boilers are now run from 30 to 42 months. Instead of ¼-in. scale when they are removed there is less than 1/16-in. scale. An engine running on one district could not work on the other without several weeks of bad leaky troubles, while the engines are now operated through from Hoisington to Pueblo, stopping at Horace only to clean fires and change crews.

On the district between Kansas City and Omaha, we formerly experienced considerable trouble with leaky staybolts, making it necessary to hold engine in for staybolt inspection and repairs about three days per month. Since complete treatment of water supplies was put into effect we practically eliminated the leaky staybolts, and engines can be returned to service in much less time.

There are among other classes 13 Santa Fe type locomotives operating on this division. By this one feature of improving water conditions so that delays from staybolt repairs were practically eliminated, it had the same effect as giving the division one additional Santa Fe type locomotive.

As an example of water treating results for stationary boilers at our Sedalia, Mo., power plant where water is treated for five Babcock & Wilcox double-deck water tube boilers of 275 h. p. each, about 650 of the 840 4-inch tubes were in service 12 years, using treated water. The raw water here contains about 20 grains per gallon of incrusting matter or nearly three pounds per 1,000 gallons, and with its use untreated, tube failures were frequent and the scale heavy and very hard.

Many such individual instances can be cited but it is very probable that any other railroad, which has given careful attention to its water problems can do likewise. In fact, although we cannot say our scale troubles have been eliminated, they have been very materially reduced. Although engine failures from leaking have not been entirely eliminated, it is a fact that they are beoming very rare.

A factor which must be given attention in the correction of water supplies is the matter of organization and supervision. The best and most expensive apparatus will not give results unless correctly and regularly operated. If a water treating plant is not properly run it is worse than useless, as it is misleading. Not only is the investment a loss, but expected results are not secured and the entire plan is discredited. Only by careful and systematic organization and by placing definite responsibility, can good results be secured. The methods which have been established and worked out for taking care of these facilities on the Missouri Pacific are as follows:

The water supply supervision is centered in the engineering department, an engineer of water service being placed in direct charge. Small laboratories in charge of traveling chemists have been installed at Little Rock, Ark., Kansas City, Mo., and Osawatomie, Kan. Samples of both raw and treated water are sent from each treating plant to the designated laboratory on each Wednesday and Saturday where tests are promptly made and reports are furnished to all concerned. Any indication of unfavorable tests results in an inspection of the plant on the ground. The treatments are governed largely by inspection of conditions in boilers, and the chemical tests are made to assure water being maintained in the condition found to be most favorable. The traveling chemists in course of their inspection consult freely with operating officials, general and division master mechanics, roundhouse and boiler foreman and others interested, and any complaint is taken care of without delay. The engineer of water service and general boiler inspector co-operate with each other and all concerned. In this manner water troubles are adjusted and minimized.

A point which is always brought up in a discussion of water treatment is the question of foaming. It is a fact that when a water softening plant is put in service, as a general rule, considerable foaming complaint results. This is also more or less true when an engine is transferred from a district where one quality of water prevails, to another; it is the result of changed water conditions and the soft water loosening the old scale, bringing about a dirty boiler condition. In most cases this trouble stops after a few weeks. We have had some foaming trouble on the Missouri Pacific, but with use of an anti-foaming preparation, which is essentially a weak acid emulsion of castor oil made up by our chemical department, this trouble has been kept at a minimum.

The chief difficulty encountered with boiler waters at present is pitting and corrosion. The solution of this problem is still under study to determine more exactly as to the cause, but in this connection it can be said that while our present system of treatment has not eliminated this trouble, the improvements in condition have been very marked.

In summarizing, permit me to again emphasize the importance of careful and conscientious study of water supply problems by a specially trained organization. This, together with close co-operation between the water service, operating and mechanical departments will insure remarkable and satisfactory results and economies. In fact, the only limit to the beneficial effect of water softening is when no delays to engines occur due to water troubles and when flues last the full government limit with but a small coating of scale. Our experience on the Missouri Pacific, where treating plants have been installed and properly supervised, have proven conclusively that these results can be accomplished.

Power Brake Hearing

As noted in our issue for January, the order of the examiners in the power brake hearing before the Interstate Commerce Commission, requires that the briefs of all interested parties shall be submitted by February 10. The date of the oral argument before the Commission has been set for February 23 and 24.

The hearing was called about a year ago; a questionnaire was sent to nearly two hundred railroads, and the first hearing was held in May last, but because of the strike subsequent hearings were postponed until November and December.

Report on a Burst Wheel

An Investigation of a Wheel That Caused a Derailment

Several months ago there was a derailment on the Atlanta, Birmingham & Atlantic Ry. which resulted in the death of seven persons and the injuring of 16 others. The immediate cause of the derailment was a burst car wheel that was broken as a result of overheating.

The Bureau of Safety has just published its investigation of the subject with the report of the engineer physicist, Mr. James E. Howard.

When the employes on the train investigated into the cause, they found a fragment of the wheel still warm an hour and a half after and two hours after the occurrence, and the brake-shoes and other wheels of the car were blued on their bearing surfaces.

The broken wheel was of cast iron and weighed 701 pounds. In our issue for July, 1922, we published an abstract of the report of the Bureau of Standards on some thermal tests of car wheels and, the reasoning followed by Mr. Howard in his analysis of this accident was in a direct line with the principles set forth in that investigation.

While not regarded of peculiar importance in the present accident, nevertheless a consideration of the influences which act upon brakes shoes and their effects, as witnessed in brake shoes themselves, directs attention to corresponding effects which take place in the metal of the treads of wheels. Thermal effects represent sources of danger to the integrity of the metal against which no wheel, of whatever type it may be, is exempt.

Internal strains induced by differences in temperature depend upon the ranges in such differences and upon the relative volumes of hot and cold metal which are in opposition, referring to differences in temperature in a wheel of one integral unit. The greater the difference in temperature the greater will be the induced internal strains. Again, the greater the volume of metal affected the greater will be the gross force required if exerted to restrain the effect of such thermal result. Increase of weight of wheel may increase the gross force exerted on the one hand, or by presenting a greater volume of metal to absorb the heat, representing the mechanical equivalent of the work done, result in a lesser rise in temperature and therefore cause lesser internal strains in adjacent parts. These are considerations which present themselves in the discussion of the causes of failure of wheels where thermal conditions are responsible factors. They present themselves in connection with this derailment, concerning which there are insufficient data to formulate a direct and positive explanation of the failure of the wheel.

The immediate examination of the wheels showed the rims to have been recently heated to such a degree that oxide tints had been acquired on the running surfaces; that thermal cracks were present on the tread of one of the wheels of the leading axle of the forward truck, in the vicinity of a slight "comby spot" and at other parts of the tread, and that a circular crack had been found on the wheel on the rear axle on the same side of the truck as the broken wheel, which extended for a distance of some 23 inches in the single plate, located in the vicinity of the junction of the outer and inner plates.

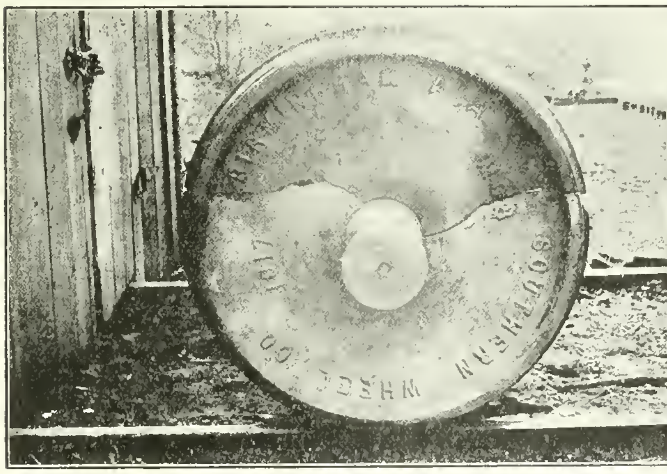


FIG. 1—FRONT VIEW OF BROKEN WHEEL, SHOWING RADIAL LINES OF RUPTURE PASSING THROUGH CHAPLETS IN FRONT PLATE. INITIAL POINT OF RUPTURE BELIEVED TO BE AT RIM ON RIGHT SIDE

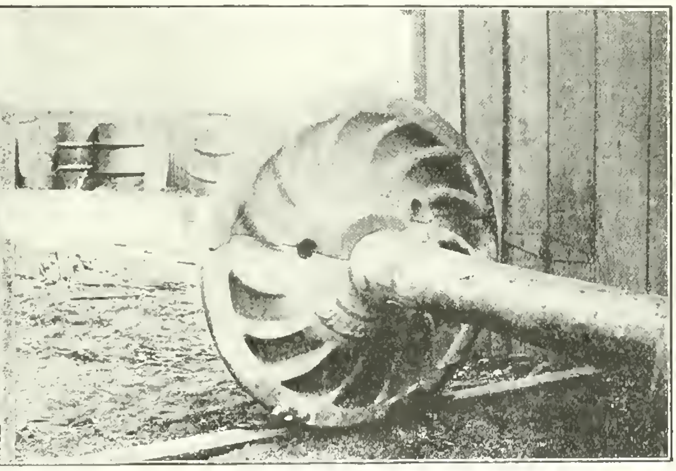


FIG. 2. REAR VIEW OF BROKEN WHEEL, SHOWING RADIAL LINES OF RUPTURE PASSING THROUGH CORE LEG OPENINGS OF REAR PLATE. INITIAL POINT OF RUPTURE BELIEVED TO BE AT THE RIM ON LEFT SIDE

The broken wheel showed two lines of rupture, each approximately radial, passing through the core leg openings of the inner plate and the chaplets of the outer plate. Substantially one-third of the wheel was separated by the sector thus detached at the time of the accident. It was also found that one of these radial lines of rupture separated the metal of the rim at a "slid-flat" spot. This line of rupture was the leading one with reference to the rotation of the wheel when in the truck.

This slid-flat spot may have been instrumental in causing the rupture of the wheel, and possibly was the immediate cause. All the wheels of the rear truck; in fact, those of both trucks, are believed to have been heated above an ordinary braking temperature on this particular run of the train.

When heated by frictional contact with the brake shoe the rim of the wheel necessarily becomes the hotter portion, and that part attains a state of internal compression, introducing radial tension in the plates as the necessary reaction to the hotter rim. Such a state would at such a time militate against a line of rupture having its origin at the rim. Commonly, segments instead of sectors are detached in broken wheels.

The line of rupture separating the slid-flat spot, at the middle of its length, is suggestive, however, of the explanation that the initial point of rupture of the wheel occurred at this place, and, if so, necessarily at a time when the metal at this particular part of the rim was in a state of tension.

Overheating the rim locally puts, for the time being, that part into a state of intense compression, into a state of overcompression, which subsequently reverses to one of tension when equalization of temperature in the wheel is reached. It seems tenable to believe that this flat spot was formed during the run on which the accident occurred at a time when the wheel as a whole was abnormally hot, the result of some temporary arrest in its rotation; that is, a flat spot was formed on a wheel of which both the rim and the plate was above the normal temperature. When rotation was resumed this slid-flat spot would promptly cool to the temperature of the adjacent parts of the rim, and in so doing reverse the internal strains to a state of tension, and thus furnish the opportunity to originate the line of rupture which was followed by complete failure of the wheel. It seems a coincidence that this slid-flat spot chanced to be radially in line with the core leg opening and chaplet of the double plate.

As thus conjecturally described, a condition would be introduced tending to cause a line of rupture to form at the tread, by reason of a state of tension being acquired at that surface, notwithstanding the wheel as a whole was in an overheated condition. It will be borne in mind that a range in temperature of 340° F. causes a dilatation in cast iron equal to a stress of 30,000 pounds per square inch with the modulus of elasticity taken at 15,000,000. At the high temperature of the slid-flat spot the tensile strength of the iron is doubtless much reduced. Ordinary cast (gun) iron, which displays a tensile strength of not less than 30,000 pounds per square inch at atmospheric temperatures, has a tensile strength at 1,500° F. of only 10,000 pounds per square inch. Therefore a range in temperature much less than 340° F. would be sufficient to strain the iron to its tensile limit, allowing a liberal modification in its coefficient of expansion and modulus of elasticity for elevation of temperature.

Evidence is frequently presented in the treads of wheels of the formation of incipient cracks which were in evidence in the wheels of this derailed car. Such a crack in the broken wheel penetrated to a depth of nine-sixteenths inch. These cracks, hair lines in appearance, represent the relief of internal strains of tension by rupture of the metal and doubtless formed at a time when the surface of the tread was momentarily at a lower temperature than the metal of the interior of the rim. Such a condition arises when the surface of the tread has been raised to a high temperature, and air cooled over the hot core or interior portion of the rim.

Such cracks have been experimentally formed by heating the rim of a chilled iron wheel by means of a torch, raising the temperature to a red heat, and allowing the wheel to cool in the air. The immediate effect of the heating was overcompression of the surface metal, straining the interior metal in tension. Upon cooling, the surface strains were reversed, becoming strains of tension, and cracks were thus formed on the surface of the tread while under microscopic observation.

The fractured surfaces of cast iron do not afford the same ready means of showing the points of origin of fractures as those which steels commonly display. Other evidence must be sought to determine the points of origin of fractures in cast irons. A probable or possible cause of failure has been pointed out, as above, in the present wheel, one which would explain why the line of rupture was located separating the tread at a slid-flat spot. This explanation of the proximate cause of rupture will be held until more extended data are acquired upon the internal strains present in chilled iron wheels and information acquired, if attainable, upon the effects of repeated brake applications in which the rims are successively heated and cooled.

Earlier observations have been made upon the internal strains in the rim, plates, and hub of a chilled iron wheel in which internal strains of tension were found present in the plate with a high state of compression at the hub. So-called split hubs are said to have their origins in the plate, thence extending in each direction through the hub to the wheel fit, and through the rim to the running surface of the tread. Measured strains in the hub of one

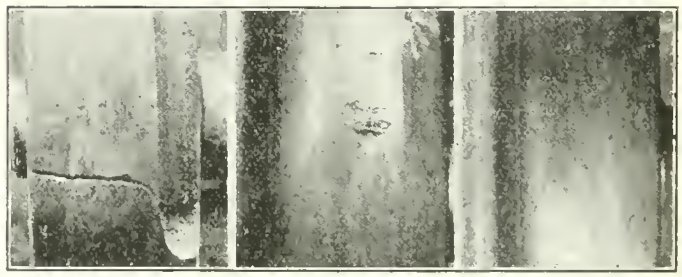


FIG. 3 FIG. 4 FIG. 5

FIG. 3. VIEW OF TREAD OF BROKEN WHEEL, SHOWING LINE OF RUPTURE LOCATED AT SLID FLAT SPOT BELIEVED TO BE THE INITIAL POINT OF RUPTURE.

FIG. 4. THERMAL CRACKS IN TREAD OF WHEEL ON FORWARD AXLE OF FRONT TRUCK OF DERAILED CAR. COMBY SPOT IN VICINITY OF THERMAL CRACKS.

FIG. 5. THERMAL CRACKS IN OTHER PART OF TREAD OF WHEEL SHOWN IN FIG. 4

wheel amounted to some 20,000 pounds per square inch compression. Strains of tension somewhat irregular in magnitude were found in the plate; likewise those of compression varied in degree in different parts of the wheel.

Importance attaches to these internal thermal strains, since they may easily exceed in magnitude the direct strains caused by the axle loads. They may augment or diminish the strains due to axle loads acording to position. A complete understanding of the wheel problem involves the consideration of these coacting forces, internal strains and external stresses, with numerical data upon the magnitude of each. Provided with such information a closer approach can be made in predicating the margin in strength which is in reserve in chilled iron wheels after they have been in service than can now be offered.

Although a thermal test is frequently made, its relation to the endurance of the wheel under service conditions does not appear to have been definitely established, a comment in respect to specifications governing the acceptance of material which need not be restricted to chilled-iron wheels. A wide gap exists between the information acquired in customary routine testing and knowledge of the behavior of the material when it reaches the track whereby a proper margin in strength and safety may be retained in the materials of both track and equipment. Efforts are being made, however, to close this gap somewhat and establish more closely definite relations between physical properties and structural states, and the endurance of materials under service conditions. Such a problem necessarily involves a consideration of all the elementary factors which service conditions call into play.

The present report is submitted as a tentative one based upon the general information at hand upon the properties of chilled-iron wheels, which is admittedly meager in relation to the state of internal strains the wheels are in when first put into service and that relating to the successive phases through which the different zones of chilled, mottled, gray iron pass during their term of service, in which thermal strains and mechanical strains each are recognized factors. In summation, evidence leads in the direction of attributing responsibility for the rupture of the present wheel to the local strains set up at the slid-flat spot on the tread. Other explanations which might be advanced are more or less in opposition to each other, and consequently untenable.

Economy of Four Cylinder Balanced Compound Locomotives

By W. E. Symons, Consulting Engineer

At a recent meeting of the New York Railroad Club there was an interested discussion on the subject of locomotive design, in the course of which both American and foreign departures from conventional types were touched upon, and reference made to proposed change of certain parts of well known standard designs.

While this discussion brought out many interesting points for consideration it was clear to one who has followed locomotive development for the past twenty years or more, that the trend of thought or consensus of opinion was decidedly in the direction of radical change in future design, rather than seeking increased economies through higher development of past or present designs, which prompts the suggestion that development of the four-cylinder balanced compound engine would be well justified at this time, and without in any way detracting from such consideration as other propositions of known merit may deserve. The balanced compounds of which there were 500 to 600 in use in this country about 20 years ago were never developed to that high degree of efficiency easily attainable today, and the absence of which may be assumed had much to do with their retirement.

Features of Refinement in Design

Among the more important features of design essential to economy in operation is separate valve gears, which should be clear to all who have studied the problem, and particularly so if one has had the opportunity to ride on an engine of this design on the other side and note from personal observation (a) the even riding qualities, (b) absence of hammer blows on track, (c) even, uniform draft on fire, (d) minimum of back pressure on low pressure cylinders, (e) and the ease with which the engine, even at high speed, may increase its speed as much as 10 to 15 kilometers per hour by simply adjusting the valve gear, which is impossible with a single gear controlling steam distribution to four cylinders.

Objection to Additional Parts

Admitting as a general proposition that additional parts or mechanism usually means additional cost for upkeep of machinery in general, it is equally true that a large powerful machine, if unbalanced, may be materially improved in operation, by the substitution of a greater number of parts, individually lighter, but producing a much more efficient machine, and with much less stress or relative wear on similar parts, and this is true with respect to the four-cylinder balanced compound engine, and it has the additional advantage of reduced water and fuel consumption, much of which should be credited to the uniform even drafting effect of exhaust on the fire, which is impossible to secure with a two-cylinder engine with cranks at 90 degree angle.

A four-cylinder balanced compound locomotive with superheater, brick arch, booster and feed water heater, would, it is thought by many who have had much to do with the development of the locomotive in U. S., be a more efficient engine for heavy through fast passenger trains than any other design. There is one other feature of the engine of great importance that should not be overlooked, and on which the writer cannot remain silent and that is the absence of the Dynamic Augment, or commonly referred to as the hammer blow.

One of the strong points favorable to the use of the four-cylinder balanced engine in this country in 1902, was that due its almost perfectly balanced parts, and more nearly constant turning torque, that it started trains easily and quickly without the uncomfortable, and at times destructive jerks so common with our standard engine with two cranks at 90 degree angles, and that when under way even at extremely high speeds, there was an entire absence of bent, kinked or broken rails or other damage to track bridges, or the engine itself, so often the case with our two-cylinder engine, and although the actual money value of these items of expense were known to be high and impossible of even close calculation, it was thought the advantages of the balanced engine would more than offset any extra expense that might attach to the construction or maintenance of the four-cylinder balanced compound.

The first four-cylinder balanced compound engine ever built in America was the twenty-thousandth (20,000) engine built by the Baldwin Locomotive Works and was completed in March, 1902, at which time the Baldwin Works jointly celebrated this event with the 72nd year of their continuous operation as a locomotive works, with a grand banquet at the Union League Club in Philadelphia, which was attended by many of the most prominent railway men in the country. Following this initial engine many others were built, one trunk line in the West purchased something like two hundred or more, there having been a total of more than five hundred in service. The late Francis J. Cole, consulting engineer for the American Locomotive Company, having worked out a design slightly different from the Baldwin.

The principle of compounding steam had long been recognized by designers in this country but the difficulties in its mechanical application to locomotives retarded progress, although during the period of 10 to 12 years prior to 1902, there had been twenty-six hundred compound engines built divided as between, Tandem cross compounds, and Baldwin four-cylinder compounds, all with cranks at 90 degree angle and heavy counter-balance in main drivers, so that while the railways had gone to great expense in developing the locomotive on economical lines, particularly with respect to fuel economy and increased tonnage hauled, the four-cylinder balanced compound was the first engine built with a view of eliminating, as far as possible, the destructive effect of the other designs, on track, bridges, etc.

An Unpopular Engine

To a close observer, however, it was soon quite clear that the four-cylinder balanced compound engine was not popular with the rank and file, particularly the engineers, train despatchers and round-house forces. To the mind of many there were two engines to look after instead of one, and one of these between the frames directly underneath the boiler, with a crank axle which they were sure belonged only in the hold of a steamship and was out of place as part of a locomotive. It can readily be seen from the above how easy it was for sentiment to gradually crystalize to such degree against the balanced compound, that the higher officers, including the chief engineers who recognized it as a great factor in reduced maintenance costs of track and bridges, found that as between the two horns of a dilemma, the lines of least resistance was in the direction of the standard two-cylinder engine with cranks at 90 degree angles and superheating the steam instead of compounding it. So that today although the simple engine has been developed up to a high state of efficiency, yet the injurious effects on track and bridges of the hammer blow from the unbalanced parts cost just as much as it did from the less efficient engine of 25 years ago, and there seems to be little or no disposition to depart from this feature of design.

Improvements Come in Cycles

A review of the various stages of development of our complete transportation systems will reveal the fact that the mental process of the great minds devoted to railway engineering are pretty much the same as those in other lines of activity. We are sometimes so wedded to a certain feature or phase of a great problem that we lose sight of another of equal or possibly greater importance, and this is particularly true with respect to locomotive design both here and abroad, and while no one competent to speak on the subject has to the writer's knowledge, withdrawn or modified their conclusions of some 15 years ago as to the injurious effect of the two-cylinder engines on track, bridges, etc., and the great advantages of the four-cylinder balanced compound engine over the former from so many angles of comparison, with such an inviting field for development it seems strange the proposition in this country lies dormant.

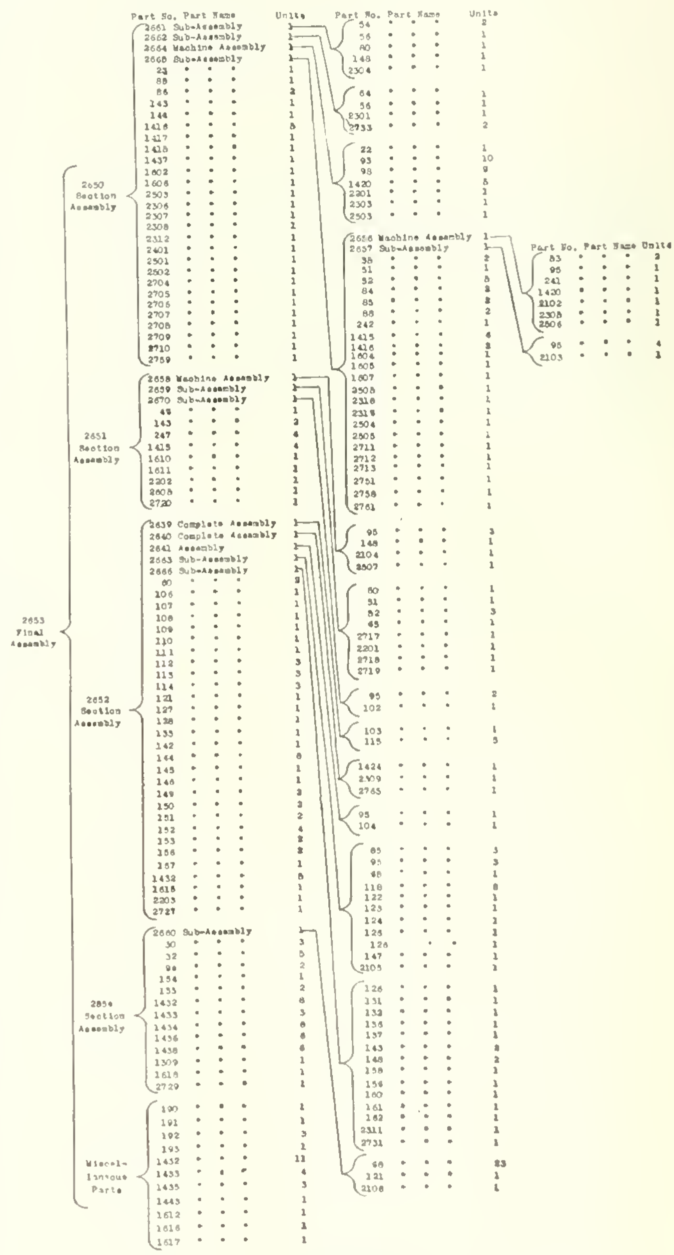
It would be gratifying news to hear that the management of one of our great trunk lines, that is spending millions on new equipment, had decided to have built, say four, four-cylinder balanced compound engines, with all the best known tried out devices that make for economy. Specialties would include the following: (a) superheater, (b) brick arch, (c) feed water heater, (d) separate valve gear, (e) booster, (f) variable exhaust. Incorporating all the good points developed in both U. S. and foreign countries, and carefully avoiding all bad features. These engines to be equal in capacity to the modern Pacific type used on heavy fast through passenger trains. When put in service alongside and in comparison with the simple engine, it is the writer's belief that the balanced compound, all things considered, will not only meet all transportation requirement, but will be equally if not more economical.

Diagraming a Product

A manufacturer of a well known product has laid out a diagram of that product for the benefit of both the shop and office forces by which the component parts of the complete or sub-assembly can be determined at a glance.

The diagram is reproduced herewith, with the suppression of the names of the details by which it could be identified. It is given not so much for the purpose of describing the methods pursued with this individual product as an example of a method that might well be followed in other lines of manufacturing as well as in car and locomotive work, where there must be a single assembly made up of a large number of details.

At the left there is the "final assembly," made up of four section assemblies and thirteen miscellaneous parts, which,



METHOD OF DIAGRAMING A PRODUCT

in this particular instance, happen to be a collection of pipe fittings, gaskets, studs and thread protectors to the total number of thirty, as shown by the figures in the column of units.

The section assemblies are themselves made up of a number of units some of which are themselves sub-assemblies built up from the parts, as shown.

For example: the first sub-assembly going into the make-up of the upper section assembly is composed of six parts and seven units, two of the latter having the same part name. The second sub-assembly is made up of four different parts; the third of seven and the fourth of twenty-five parts. And so through the other three section assemblies.

The subdivision is carried out until there are no more assemblies of two or more parts.

With this diagrammatic arrangement it is possible for the office to order the whole complete assembly, any sub-assembly or any isolated part of the whole by number and for a foreman to requisition or make and the storeroom to issue all individual parts in the correct number of units without any further information and without delay.

The method of classification adopted is to consider an assembly or sub-assembly a part composed of two or more parts, which are put together before being placed in the next higher assembly and which are put in that next higher assembly as though it were one part.

For example: the assembly No. 2656 is made up of seven parts and eight units. These are all brought together and assembled as though they were a complete machine, and are then further assembled with the other twenty-four parts, which include thirty-eight individual units to form the sub-assembly No. 2665. And this is put with its associates to form the section assembly No. 2650.

There is hardly a product that is built up of a number of parts that is not composed of a number of assemblies of a similar character and which could not be profitably diagramed in this way.

New York Railroad Club

The first meeting of the New York Railroad Club of this year was called to order by President Dickerson in the Engineering Societies Building ond January 19th.

The meeting opened with three short addresses which furnished a basis for the evening's program.

Walter B. Russell, Director of Franklin Union, Boston, spoke on educational features, and their value to officers and employes of railways, pointing out specific cases coming under his personal observation. Doubtless much good has come from the system followed by Mr. Russell, and the field for future progress on these lines is broad and inviting.

John Draney of the Lackawanna in his original and very interesting manner, outlined the aims and possibilities of the Veterans' Association, giving due credit to certain well known railway executives for their cheerful co-operation and assistance. There was no discussion of the subject matter of Mr. Draney's address for the simple reason it was so clearly and completely covered, there was no room for anything to be added. Doubtless these associations will not only extend to other systems but will be alike helpful to the membership, employes in general, and the companies.

A. F. Stuebing, managing editor of the *Railway Mechanical Engineer*, gave an interesting talk on the subject, "Are We Due for a Radical Change in Locomotive Construction?" in the course of which many angles of the past, present and possible future status of our motive power was brought out.

Following Mr. Stuebing's remarks, the subjects were thrown open for general discussion, which was participated in by several and much valuable information brought out.

Mr. Stuebing called attention to the fact that experimental engines of the Turbo-generator, and the Ramsay Turbo-electric, both radical departures from our conventional design, were in actual operation on the other side, while a proposed change in methods of drafting our standard engines was presented as a means of greatly increasing their efficiency and reducing the quantity of fuel burned.

The discussion was opened by one of the best known and ablest engineers in the country, Dr. Elmer A. Sperry, who has not only achieved success in practical commercial engineering lines but is a man of high scientific attainment. Dr. Sperry reviewed much of the progress made with the Diesel Engine as an economical prime mover, particularly in marine practice, and mentioned its possible use on railways. Dr. Sperry's discussion was highly interesting and instructive to all who are interested in the features touched upon.

A New Design of Four-Cylinder Engine

Dr. James G. Dudley, consulting engineer, seemed to be of the opinion that little progress had been made in the development of our locomotives during the past 18 years, in fact Mr. Dudley quoted figures to show they were some ten per cent (10%) less efficient than in 1904, and suggested a new type of locomotive, supported on and drawn by two separate four-wheel tracks, with four cylinders. As to whether the engine was single expansion or compound, Tandem or Crank axle, superheated or saturated steam, or other details of design, were not made clear, although the speaker felt sure it would show wonderful economies over present designs.

W. E. Symons, consulting engineer, discussed the question of engine design at length, and while favoring electrification where and when possible or desirable from physical operating or financial standpoint or other improved methods of proven worth, differed on some points with Mr. Stuebing, and took issue with Mr. Dudley in an ineffectual effort to learn details of design of his proposed improved four-cylinder engine.

Mr. Symons took the position that we have the most ultra modern equipment in use, and that while all well informed people know of this fact, there was and has been an insidious propaganda carried on against railway interests, calculated to impair their credit and poison the minds of the general public against them, and that one of their forms of procedure was to declare that our railways were inefficiently managed, that the locomotive cars, etc., were antiquated, that in general we were old fashioned and out of date, all of which is unwarranted and much of which is just a plain falsehood.

The positon was also taken by Mr. Symons that we had led the world in locomotive development during the past 20 years, and to talk about cutting 30 per cent to 50 per cent off our fuel bill by some different methods of drafting engines was tantamount to saying that our railway officers and locomotive builders, who have developed our locomotives up to their present high standard of efficiency, are 30 per cent to 50 per cent behind the times, and are, figuratively speaking, "asleep at the switch," which is entirely unwarranted.

Four-Cylinder Balanced Compound Engines

Mr. Stuebing spoke of the Compound engine as having been tried and, found wanting, and on this point Mr. Symons agreed it had been tried and retired, but held dissenting view as to the merits of the four-cylinder balanced compound, pointing out that while the crank axle was an undesirable feature, yet the complete unit met a condition found in no other type, namely; almost complete elimination of, or freedom from the injurious effect of the Dynamic Augument or Hammer Blow, on rails, bridges, etc., unlike our conventional design with only two cranks at 90 degree angles, when running at fast freight and passenger train speeds.

Mr. Symons offers the following in amplifying his reply to Mr. Dudley, who quoted figures to show that the steam locomotive had retrograded 10 per cent in efficiency the last 18 years.

In speaking of the development of the steam locomotive recently G. M. Basford said:

"Steam locomotives have been improved, and the present generation of engineers has brought to the steam locomotives improvements which were *not* dreamed of ten years ago, and the possibilities of which are not yet apparent to all railroads at the present time. It is important that electrical engineers should know that the steam locomotive of today offers possibilities that are far beyond those of the steam locomotive of *ten* or more years ago."

In addition to Mr. Basford's statement as to the wonderful progress in steam locomotive development in the past 10 to 18 years the following is offered as an additional tribute to those who have contributed to this most gratifying result:

	Number, Tractive Power and Weight				Tons, Rate and Costs			
Year	Number	Tractive Power in Pounds	Average Per Engine	Weight in Tons	Rate Tons Per Train	Per Ton Mile	Cost of Fuel Per Ton	Per Cent G. E. to Labor
1904	46,743	1,063,651,261	22,751	62.1	308	7.80	$1.10	41.39
1905	48,357	1,141,330,082	24,429	63.6	322	7.66	1.06	40.34
1906	51,672	1,277,865,673	......	66.9	344	7.48	1.11	40.02
1907	55,336	1,429,626,658	......	69.1	357	7.59	1.14	41.42
1908	56,867	1,498,793,551	......	71.0	352	7.54	1.12	43.26
1909	56,468	1,503,971,444	......	72.0	363	7.68	1.07	40.86
1910	58,240	1,588,894,480	......	73.5	380	7.53	1.12	41.58
1911	60,162	1,681,495,905	......	75.	383	7.57	1.11	43.32
1912	61,010	1,746,964,128	......	77.	407	7.44	1.15	44.05
1913	62,211	1,847,798,393	......	80.	445	7.29	1.18	43.99
1914	63,510	1,931,953,982	......	83.	452	7.33	1.17	45.09
1915	63,850	2,014,201,560	......	86.	474	7.32	1.12	43.20
1916	62,997	2,059,044,000	......	87.5	553	7.16	1.24	41.09
1917	63,823	2,143,698,000	......	89.4	620	7.28	2.07	43.71
1918	64,410	2,196,698,349	......	90.	656	8.62	2.56	54.06
1919	65,021	2,229,151,000	34,283	91.2	675	9.62	2.47	55.47
1920	66,511	2,379,157,000	36,010	90.	629	10.64	3.22	59.74
1921	66,721	2,449,616,000	36,714	96.	596	11.13	2.89	50.57
1922	......	....	......	....	....	....	....	.....
Per cent increase	42.5%	129%	61.3%	54%	128%	....	163%	....

From the foregoing table it appears that during the past 18 years the number of locomotives have increased from 46,743 to 66,721, or 42.5 per cent, while their weight in tons, has increased 54 per cent, the average tractive power 61.3 per cent, the total tractive power 129 per cent, and the average tons per train 128 per cent. It may also be of interest to know that of every dollar earned by a locomotive, labor received more than one-half of it. The average price of fuel has advanced 163 per cent, but freight rates have only advanced 3.33 mills.

In a very interesting paper by James Partington before the American Society of Mechanical Engineers in December, 1921, he showed the coal consumption per horsepower at the drawbar for two modern locomotives, one a heavy Pacific type passenger engine, the other a heavy Mikado freight engine, at 2.14 lbs. for the one, and 2 lbs. for the other, or an average of 2.07 lbs., or more than 40 per cent

Owner, Number, Service and Description					Pounds Coal Per Horsepower at Drawbar			
Name of Company	Number	Service	Wheel Arrangement	Description	No. of Tests	Max. Coal Used	Min. Coal Used	Aver. Lbs. Coal Used
Penn. R. R	1,499	Fr't	2-8-0	Simple	17	7.19	3.54	5.36
L. S. & M. S.	734	Fr't	2-8-0	Simple	16	5.80	3.36	4.58
Mich. Cent...	585	Fr't	2-8-0	2 cy comp.......	13	4.44	2.14	3.29
Santa Fe.....	929	Fr't	2-10-0	2 cy. tandem c...	9	3.74	2.70	3.22
Santa Fe.....	535	Pass.	4-4-2	4 cy. balan.......	11	5.60	2.66	4.13
German	628	Pass.	4-4-2	4 cy. bal. su. hea..	10	5.31	2.52	3.92
N. Y. Cent..	3,000	Pass.	4-4-2	4 cy. bal. com.....	11	4.65	2.53	3.59
French	2,515	Pass.	4-4-2	4 cy. bal. com.....	10	5.48	2.19	3.83
Totals & Aver.	...	....	.....	....	97	5.27	2.70	3.99

over the St. Louis figures of 1904, while another test record of these same engines showed one engine as using 2.12 lbs., and the other only 1.52 lbs., or an average of 1.82 lbs., which is about 32.5 per cent better than a average of the best results at St. Louis in 1904, and over 54 per cent over an average of the high and low of 97 tests of eight engines, four freight and four passenger, among the latter being one French and one German.

The foregoing record of facts would seem to fully support those who contend that wonderful strides have been made in the development of the steam locomotive during the past 18 years, and when measured by the pounds of coal per horsepower delivered to the drawbar there seems to be abundant evidence that instead of retrograding 10 per cent it has actually gone forward more than 30 per cent.

That the railway engineers of America will keep abreast of those in other countries, both in the character and design of prime movers and in economy and efficiency in operation we can rest well assured.

Standardization of Methods of Testing Wood

Innumerable misunderstandings and disagreements concerning strength of lumber and timbers, and such accidents as grow out of miscalculation of the strength of various kinds of lumber, should be greatly reduced as a result of the standardization of methods of testing wood, recently undertaken by the many interests involved, under the auspices of the American Engineering Standards Committee.

The U. S. Forest Service and the American Society for Testing Materials have been appointed joint sponsors for this undertaking, and 16 additional organizations are represented on the sectional committee which is to make an intensive study of the subject.

The scope of the committee's activities embraces the standardization of physical (including mechanical) tests of wood specimens. Of immediate importance is the application of these tests to (a) small clear specimens, and (b) structural timbers. The most important desideratum involved in the establishment of standard practice in testing wood which will make data obtained at different sources of the broadest possible value and insure the attainment of comparable results.

The need for this particular standardization undertaking is aptly described in a communication received by the A. E. S. C., from the U. S. Forest Service and the American Society for Testing Materials, joint sponsors for this project, which says in part:

"Even a casual glance at engineering literature will reveal detailed specifications for the testing of such materials as steel, cement, and other products, but no such well-known specifications and procedure are available in regard to the testing of wood. This is probably due to a number of causes, among which are the decentralization of the lumber industry, the production and distribution of lumber by numerous small and independent units rather than a few large plants, and lack of appreciation of the variability of timber and the factors influencing it, and the inability to determine definitely the quality of any shipment of material by selecting a relatively small number of samples as can be done with other products.

"Because of this lack of standardization in methods of testing wood, the results which have been obtained by different investigators very frequently cannot be correlated due to various factors which influence the results. These factors are very numerous and include the rate at which the load is applied, the moisture content of the timber, the size and proportion of the test, the quality of the material, the position in the tree from which the material is selected, defects present, as well as the details of the apparatus used in a given test. Much of the data on tests of wood are of little or no value because of lack of standard procedure in testing."

Snap Shots—By the Wanderer

It looks very much as though it would be necessary for the railroads to put still further restrictions upon the private life of their employes, if the maximum safety of operation is to be obtained. There was a time when "a railroader" was a synonym for a rough character and a heavy drinker. It was in the days of hand brakes and the link-and-pin coupler. The work was hard and dangerous. The trains were short, rarely reaching twenty cars, but it was usually necessary for at least two men to ride outside. The exposure and the hardships encountered engendered a recklessness, which coupled to the general misapprehension that whiskey is a body warmer, was productive of hard drinking by all members of the freight crew.

Men of this stamp were, in time, found to be unreliable, especially when partially intoxicated, and it is now nearly fifty years since the railroads began to require, at first, perfect sobriety while on duty on the part of the engineers, then of the rest of the train crew and this restriction was later brought to the point of a requirement of total abstinence until now it is recognized everywhere that "a railroader" in good standing is a man of almost exemplary personal habits.

Then it came to be recognized that long hours of service and fatigue were strong contributing elements to general incapacity and promoters of the liability to mistakes and accident. So the law took the matter in hand and stipulated that no train crew should work for more than sixteen continuous hours, and that after a period of work there should be an interval of at least eight hours of rest. Certainly a short enough time.

Now comes a further point. Is it enough that a man should not be working during his eight hours of freedom? As matters stand he is free to do as he pleases. He may work about his own affairs, he may play or do anything but rest if he is so inclined. Should he be thus free to do as he pleases? It is suspected that the engineer of a fast train that was in an accident of many fatalities a short time ago, had not utilized his hours of freedom for rest and that he was dozing at his post.

Again is rest a guarantee that the man is mentally fit to assume the great responsibility of running a train? It is quite possible that a man may be physically quite fit, and mentally not only unfit but actually a dangerous man to put in charge of a train.

For example: it is not so many years since there was a terrible disaster caused by overspeeding. The man responsible was thoroughly competent, and had not been overworked. But he had recently lost his wife; his two children were sick with diphtheria, and his sister was not expected to live. He simply could not think of his work. He did not realize his mental condition and his superintendent did not know of it, and nearly one hundred people were killed as a consequence thereof.

It, therefore, seems quite proper that a railroad company should exercise a careful surveillance over the way in which train employes spend their "hours of rest." The trains they handle are too valuable, and the lives in their care too many to be trusted to men who are not fit and the pity is that it frequently happens that the man himself is quite unconscious of this unfitness.

Such surveillance should not be resented as an objectionable prying in to one's private affairs, but should be welcomed as a protective guardianship of the man himself and the public that trusts itself to his care.

Train schedules seem to be made out on a scheme that gives the train just about time enough to cover the division under ordinary working conditions with nothing to spare. A little delay is apt to mean running late the balance of the way to the terminal; a general statement made with a full knowledge of the fact that trains do frequently make up some time. As I said, the schedules *seem* to be made up on the principle of ordinary operation, which means that employes will use their ordinary amount of exertion in handling baggage and express matter and that passengers will move with their usual leisureness. To an onlooker who has checked and timed these performances many times, it *seems* as though here was the chance to save time and make up some that was lost.

Express and baggage matter is not handled as rapidly as it *could* be handled by the same men with a little extra exertion and speed. On a long run with a local train a minute or even a minute and a half could often be cut from the station stops on the average. If there are twenty stops this would be equivalent to the making up of 20 minutes of lost time. Then add the few seconds to be gained by a little alertness on the part of the conductor and the train crew and there at once appears the possibility of making up some of the time that has been lost.

Isn't it easy to make suggestions? So very much easier to think of things than do them. If suggestions and exhortations could only produce results in every case, reformers would have to work overtime in order to think of new schemes for the good of their species. So while it is easy to say that lost time could be made up if baggage and express handlers would put a little pep into their work, I confess to my inability to go farther. How to make men take an interest in their work and exert themselves for their company with but half the intensity that they would put into their own affairs I know not. It is said that poets are born not made. The same is true of the earnest worker. Still it does seem as though anything so desirable as the hurrying up of a delayed train ought to be possible of accomplishment.

The shop strike is a thing of the past. It cost millions of dollars in cold, hard tangible cash. It cost other millions in annoyance, and intangible matters that cost money but of such an illusive nature that they cannot be accurately estimated. There were no end of well-authenticated statements of bad order cars and locomotives. Reports that might be paralleled by the truthful statement: "There is a dead man in the gutter down the street," made by a murderer who might add but doesn't: "I know he's there because I killed him."

So the statements about the bad order rolling stock could be verified if they had only been complete. They should often have read: "The journals on that train ran hot, I know it because I filled the boxes with sand. That train didn't get out of the yard, I know it because I stole a lot of the journal brasses. That air brakes on that train were useless; I know it because I cut an end of the hose. That train had to be sent to the rip track, I know it because I pulled forty or fifty of the brakeshoe keys." And so the story might be strung out indefinitely, and told over a wide extent of territory.

This is not a fancy of the imagination, but rather a close adherence to what would have been a truthful statement if the truth and the whole truth had been told.

The public had little appreciation of what was done to make sure that statements regarding defective rolling stock were based on facts. It would be easy for any one with an eye for figures to roll up some astounding totals as to such performances The thing that surprises an outsider is that the railroads should have been so seemingly reluctant to publish items of this character. Possibly they feel that their friends knew how things were going and their enemies would not believe them.

It must have come very hard for a shopman to relinquish the fat things of this life that fell into his lap in the course of government control. All men like a sinecure. To be paid for work that is not done and is not even expected to be done is very sweet. And when there appears to be a chance of all these goods, that the powers that were in Washington had conferred, were to be snatched away, it is small wonder that he struck. But the holder of a sinecure surely gets much sympathy when it is snatched away, and so the public did not mourn when the strike was lost.

New Steel Cars for Suburban Service in India

By Our India Correspondent

With the expected early advent of electrification, the Great Indian Peninsula Railway deemed it advisable to look ahead and be prepared with steel cars ready for service on the electrified sections as soon as these can be prepared. The new trains will at present run in the steam operated service, and replace or augment the trains already in local traffic. The responsibility for the design of these cars rests with the Carriage and Wagon Superintendent Mr. A. M. Bell of the G. I. P. Railway, while the construction was entrusted to Messrs. Cammell Laird & Co., at their Nottingham Works, England. The underframe is similar to the standard adopted by the I. R. C. A., but modified to receive the steel superstructure above. The bodies are 68-ft. long and 10-ft. wide, built up of steel of 14 and 16 S. W. G. thickness with mouldings electrically welded in place. The roofs, ends, etc., have been brought out to India in assembled sections to be then secured in position on the underframing by riveting. The internal finish of the cars is in Indian timber; the seating arrangements for 100 passengers in the III class have been prepared at Matunga, ready for incorporation in the bodies as they are erected.

The cars will be vestibuled together so that a passage will exist throughout the train, the general style of the subway trains in London and New York having been followed. The doors slide, and are balanced, so that a push on one represents a pull on the other; it is intended for the present that passengers will operate these doors themselves, but on leaving a station platform a push from one of the staff will cause the doors to come together and close.

Rolled steel wheels are used. Buffers of special double action type, and couplings which permit of very close attachment, are provided.

Provision is made in every fourth car for a motor control and it is intended when these cars are in the electric service, to operate the brakes with compressed air, and the sliding doors will be manipulated by the same force.

The use of compressed air for handling doors on the subways in New York has been a decided success, and the application of the principle to the cars of the Great Indian Peninsula Railway is the first to steam railway cars as a preliminary towards subsequent electrification.

NEW STEEL CAR FOR SUBURBAN SERVICE ON THE GREAT INDIA PENINSULA RAILWAY

B. of L. E. to Have Bank in New York

The Brotherhood of Locomotive Engineers has acquired a substantial interest in the Empire Trust Company of New York, and Grand Chief Warren S. Stone of the Brotherhood has been made one of the directors. Mr. Stone has announced that they will now open a bank in New York.

The new bank will be conducted on the co-operative principle, the same as the Brotherhood's Cleveland bank, which has been remarkably successful thus far. The Brotherhood and its members will own all the stock of the new institution. The name of the proposed bank and its capitalization will not be made known until the charter is applied for. It is said that the new bank will have several branches in various parts of the city.

The Central Trades and Labor Council of New York for a time had planned to join with the engineers in this banking venture, but later decided to start a bank of their own. They have accordingly applied for a state charter for the "Federated Trust Company," capitalized at $2,000,000, and have retained W. F. McCaleb, formerly manager of the engineers' Cleveland bank, to direct their institution for them.

Notes on Domestic Railroads

Locomotives

The New York Chicago & St. Louis R. R. is in the market for nine Pacific type locomotives, fifteen Mikado type, and seven switchers.

The St. Louis Southwestern Ry. is reported to be in the market for 15 locomotives of the Consolidation type.

The Great Northern is in the market for 25 Pacific type and 25 Mountain type locomotives.

The Chicago Junction has ordered 5 0-8-0 type switching locomotives from the Lima Locomotive Works.

The Bingham & Garfield is inquiring for 9 0-6-0 type switching locomotives and for one Consolidation and one Mallet type locomotive.

The Oliver Iron Mining Company has ordered 12, 8-wheel switching locomotives from the American Locomotive Company.

The Louisville, Henderson & St. Louis has ordered 5 Pacific type locomotives from the American Locomotive Company.

The Virginian has ordered 15 2-8-8-2 Mallet type locomotives from the American Locomotive Company.

The Pennsylvania R. R. has authorized the construction of 300 locomotives, of which 125 will be built at the Company's shops at Altoona, Pa., and 100 by the Baldwin Locomotive Works. Allotment on the remaining 75 will be made later.

The Illinois Central has ordered 35 Mikado type from the Baldwin Locomotives Works and 15 Mountain type from the American Locomotive Company.

The Chicago & Eastern Illinois has ordered 10 Mikado type locomotives from the American Locomotive Company.

The New York, Chicago & St. Louis has ordered 30 Mikado type locomotives from the Lima Locomotive Works.

The Central of New Jersey has ordered 6 suburban locomotives from the Baldwin Locomotive Works.

The Union Pacific R. R. mentioned in our January issue as contemplating the purchase of 78 new freight locomotives, has ordered 18 locomotives of the Santa Fe type and 5 of the Mallet type from the American Locomotive Co. It has also ordered 37 locomotives of the 2-10-2 type from the Lima Locomotive Forks, and 18 of the same type from the Baldwin Locomotive Works.

The Canadian National Railways are reported to have placed an order for 26 locomotives of the Mountain and Mikado type.

The St. Louis Southwestern Railway is inquiring for 15 locomotives of the Consolidation type.

The New York Central R. R. is reported to be in the market for repairs to about 50 locomotives.

The Philadelphia & Reading Railway is ordering material for 5 new high-speed Pacific passenger type locomotives which will be built at the company's shops at Reading, Pa. These locomotives will be the same type as now used by the company in main line service.

The Chicago, Rock Island & Pacific is inquiring for 30 Mikado type and 10 Mountain type locomotives.

The Buffalo, Rochester & Pittsburgh Ry. has placed an order with the American Locomotive Company for 5 Pacific type locomotives, 17 Mallet type locomotives, and 8 eight-wheel switching locomotives.

The Pere Marquette Ry. is taking bids on 20 eight-wheel switching locomotives.

The Cambria & Indiana R. R. is reported to be in the market for 2 locomotives of the Consolidation type.

The Mobile & Ohio R. R. is said to be in the market for 3 locomotives of the Pacific type and 6 of the Mikado type.

Freight Cars

The Great Northern has ordered 1,000 U. S. R. A. standard box cars from the Pullman Company and has also ordered 500 automobile cars from the American Car & Foundry Company.

The Chicago & North Western contemplates buying from 750 to 1,000 refrigerator cars.

The Chicago, Burlington & Quincy has placed an order for repairs to 200 tank cars with the Streets Company.

The Philips Petroleum Company, Bartlesville, Okla., has ordered 100 tank cars from the Standard Tank Car Company.

The Chicago, North Shore & Milwaukee is inquiring for 10 general service cars and 15 gondola cars of about 50 tons' capacity.

The Buffalo & Susquehanna is inquiring for 200 all steel hopper car bodies of 55 tons' capacity.

The General Petroleum Corporation has ordered 21 insulated tank cars of 10,000 gal. capacity from the Pennsylvania Tank Car Company.

The Pacific Fruit Express has placed an order with the American Car & Foundry Company for 200 special refrigerator cars, and has also purchased 100 from the General American Car Company.

The Fruit Growers Express has entered the market for 1,900 refrigerator cars.

The Chicago, North Shore & Milwaukee R. R. is in the market for 15 gondola cars and 10 general service cars.

The Westmoreland Coal Company, of Philadelphia, has placed an order with the Pressed Steel Company for 200 hopper cars.

The Chicago, New York & Boston Refrigerator Company is in the market for 100 steel underframes.

The Kansas, Oklahoma & Gulf Ry. has entered the market for 300 50-ton steel underframe gondolas, 100 40-ton gondolas, and 100 50-ton general service cars.

New York, Chicago & St. Louis R. R. is in the market for 500 composite gondola cars.

The Canadian National Rys. are reported to have purchased 500 box, 100 coal and 100 general service cars from the Eastern Car Company; 1,000 box cars from the National Steel Car Corp.; 100 box and 100 ballast cars from the Canadian Car & Foundry Company.

The Ulen Contracting Corp., of New York, is reported to have placed an order with the Magor Car Corp. for 35 flat cars.

The Republic Iron & Steel Company is inquiring for 50 flat-bottom gondola cars of 70 tons' capacity.

The General Petroleum Corporation has ordered 21 insulated tank cars of 10,000 gal. capacity from the Pennsylvania Tank Car Company.

The Elgin, Joliet & Eastern is inquiring for 300 structural steel side-dump cars and 500 composite gondola cars, both to be of 70 tons' capacity.

The Southern Pacific has ordered 575 50-ton general service cars from the Ralston Steel Car Company and is having 500 logging cars built in the shops of its Pacific system.

The Southern Pacific Company has ordered 3,700 50-ton box cars from the Standard Steel Car Co.; 350 50-ton flat cars from the Ralston Steel Car Company, and 500 40-ton stock cars from the Pullman Company. The carrier will also build 300 flat cars in its own shops.

The Baltimore & Ohio R. R. has placed orders as follows: 100 55-ton steel hopper cars to the American Car & Foundry Company; 1,000 70-ton gondola cars to the Cambria Steel Company; 1,500 hopper cars to the Pressed Steel Car Company; 500 hopper cars to the Standard Steel Car Co.; 500 hopper cars to the Ralston Steel Car Company, and 500 hopper cars to the Youngstown Steel Car Company.

The United Gas Improvement Company, of Philadelphia, Pa., has placed an order with the American Car & Foundry Company for 150 50-ton coal cars.

The Chicago, Rock Island & Pacific Ry. is reported to have ordered 250 flat cars from the American Car & Foundry Company; 250 refrigerator cars from the General American Car Company, and 500 automobile cars from the Bettendorf Company.

The Mobile & Ohio R. R. is in the market for 500 box cars, 100 stock cars, and 200 hopper cars.

The Chicago, Indianapolis & Louisville Ry. is reported to be in the market for 300 steel underframes and superstructures.

The Illinois Central is inquiring for 1,500 box cars and 2,000 composite gondola cars.

The Imperial Coal Corporation, Johnston, Pa., is inquiring for 1,000 hopper cars.

Passenger Cars

The Illinois Central R. R. is in the market for 50 various type passenger cars.

The New York Central R. R. is in the market for nine combination baggage and mail cars.

The New York Consolidated R. R. has purchased 50 steel passenger cars from the Pressed Steel Car Co.

The Canadian National Railways has ordered 50 express refrigerator cars and 10 baggage cars from the National Steel Car Corporation; 10 mail and express cars, 35 coaches, 20 sleeping cars and 20 baggage from the Canadian Car & Foundry Company.

The Mobile & Ohio R. R. has ordered from the Pullman Co. 2 passenger coaches.

The Baltimore & Ohio is inquiring for 4 dining cars.

The Atlanta & West Point R. R. has purchased 2 steel baggage cars from the Bethlehem Shipbuilding Corporation.

The Bangor & Aroostook is inquiring for 4 steel underframe baggage cars.

The Union Pacific has ordered 10 steel dining cars and 8 steel observation cars from the Pullman Company.

The Central of Georgia has ordered 2 baggage and express and 2 partition coaches from the Pullman Company.

The Western Pacific has ordered 20 coaches and 8 dining cars from the Pullman Company and 20 baggage cars from the Pressed Steel Car Company.

The New York Central has ordered 6 coaches from the American Car & Foundry Company. These are for use on the Peoria & Eastern. An order has also been given to the Standard Steel Car Company for 8 combination baggage and mail cars for use on Michigan Central and for 1 combination baggage and mail car for use on the Toledo & Ohio Central.

The Union Pacific R. R. has placed an order with the Standard Steel Car Company for 21 baggage and mail cars.

The Missouri Pacific R. R. have purchased 17 steel coaches from the American Car & Foundry Company.

The Chicago & Northwestern Ry., has ordered 200 refrigerator cars from the Pullman Co.

The New York Central is building 60 milk cars at the shops of the Merchants Dispatch, and is having a dynamometer car built in its West Albany shops.

The American Railway Express has ordered 150 express refrigerator cars from the General American Car Company.

The New York Central has ordered 6 coaches from the American Car & Foundry Company. These are for use on the Peoria & Eastern.

The Central Vermont will have 8 coaches and 2 baggage cars built at the Port Huron, Mich., shops of the Grand Trunk.

The Ligonier Valley is inquiring for one Suburban coach and one suburban passenger and baggage car.

Supply Trade Notes

F. W. Stubbs, formerly mechanical engineer of the Chicago Great Western has been appointed mechanical engineer of the **Standard Stoker Company**, with headquarters at Erie, Pa.

S. E. Marks has been appointed director of traffic and shipping of the **Westinghouse Electric & Manufacturing Company.** Mr. Marks will have charge of the traffic, shipping, and packing in all the electric plants at East Pittsburgh, Pa.; East Springfield, Mass.; Newark, N. J; Mansfield, Ohio; Trafford, Pa.; Derry, Pa.; South Bend, Ind., and Homewood and Pittsburgh, Pa.

S. I. Hopkins has been appointed manager of the **Safety Car Heating & Lighting Company's** St. Louis, Mo., office.

H. M. Clawson, formerly assistant to the vice-president of the **Franklin Railway Supply Company, Inc.**, has resigned to become assistant eastern sales manager of the **Buda Company**, with headquarters at New York.

B. G. Lamme, chief engineer of the **Westinghouse Electric & Manufacturing Company**, in recognition of his many notable engineering achievements has been awarded the Joseph Sullivant Medal of his Alma Mater, Ohio State University.

The Safety Car Heating & Lighting Company has acquired the business of the Stone Franklin Company, Inc., for the United States and Cuba, and will hereafter furnish Stone Franklin Equipments where required, as well as the necessary spare parts for the maintainance of equipments now in service.

The Westinghouse Electric & Manufacturing Company, announces that the work on it's new $700,000 building in Chicago is well under way. The building which is located at West Pershing Road and Leavitt Street, will be used for a combination district sales office, warehouse, and service shop and is the first of three buildings to be erected at this location. It will be seven stories high, will contain 218,000 sq. ft. of floor space, and will be of reinforced concrete construction. Work was started November 1 and will be completed about the first of next May.

W. P. Thomas, who became service engineer with the **Franklin Railway Supply Company, Inc.**, on January 1, 1923, has had twenty-two years' railroad experience. Mr. Thomas began as a fireman on the Chicago Great Western R. R. in 1901. He remained with this road until 1912, when he resigned to accept a position with the Chicago, Milwaukee and St. Paul at Three Forks, Montana. In 1918, Mr. Thomas left the C. M. & St. P. to become road foreman of engines on the Minneapolis and St. Louis, with headquarters at Minneapolis. In 1921 he was transferred to Marshalltown, Iowa, where he remained until he resigned to join the Franklin Railway Supply Company, Inc.

The Flannery Bolt Company, Pittsburgh, Pa., announces that it has filed suit in the United States District Court against the American Locomotive Company and the Baltimore & Ohio Railroad Company, alleging patent infringement. It is averred in the bill of complaint that the American Locomotive Company manufactured and sold locomotives in which were embodied and used stay bolts made in accordance with a patent, the rights to which are held by the Flannery Company. It is also alleged that the Baltimore & Ohio Railroad Company conspired with the American Locomotive Company by ordering and procuring the American Locomotive Company to manufacture and sell to the Baltimore & Ohio railroad the stay-bolts involved in the alleged infringement.

The Oxweld Acetylene Co. announces that its Western Dept. formerly located at 1077 Mission St., San Francisco, has recently moved to larger quarters in the same block. The new address is 1050 Mission St.

Mr. Leo Romney, Manager of the Western Dept., states that the move to new quarters in San Francisco was made necessary by the rapidly growing business on the Pacific Coast. At the new location the Company occupies the entire building, two stories and basement, 20 x 150 ft., which affords better facilities for the warehousing of surplus stocks of welding and cutting apparatus, supplies, acetylene generators, etc., for private and general offices and for an apparatus repair service department such as the Company maintains at stations in industrial centers throughout the country. On the Pacific Coast and in the Rocky Mountain States, such stations are located at Seattle, San Francisco, Los Angeles and Salt Lake City.

The growth of the Western Dept. of the Oxweld Acetylene Co. is very representative of the growth of the welding and cutting industry as experienced in the country generally and indirectly reflects a general revival of trade and manufacturing.

Decision in Locomotive Stoker Patent Suit. The United States Circuit Court of Appeals for the Third Circuit, at Philadelphia, on January 3rd, handed down a decision in the suit of the Locomotive Stoker Co. vs. The Elvin Mechanical Stoker Co., which was brought in the U. S. District Court for the District of Delaware. Infringement was charged of the Gee and the Street Patents for locomotive stokers, and Judge Morris, in the District Court, held that there was not infringement of the Gee Patent, but that the Street Patent was infringed. The Court of Appeals affirmed this decision as to the Gee Patent, and reversed it as to the Street Patent, holding that neither Patent was infringed by the Elvin Mechanical Stoker Co., and ordering the suit to be dismissed as to both Patents. The case was argued, in both Courts, by Louis K. Gillson, of Chicago, and Paul Synnestvedt, of Philadelphia, for the Locomotive Stoker Co., and by J. Snowden Bell and Drury W. Cooper, both of New York, for the Elvin Mechanical Stoker Co.

William T. Lane, effective January 1, became Western Sales Manager, **Franklin Railway Supply Company, Inc.** Mr. Lane will make his headquarters at Chicago, with J. L. Randolph, Vice President in charge of western territory. Mr. Lane has spent his entire business career in the railway supply field. On leaving college he entered the employ of the Franklin Portable Crane and Hoist Company as apprentice. His next position was that of draftsman with the Franklin Railway Supply Company, Inc., later becoming Chief Draftsman. In 1915 he was made Mechanical Engineer, and in 1919, District Sales Manager at San Francisco. In 1921 Mr. Lane was transferred from San Francisco to Cleveland as District Manager, Central Territory, the position which he held at the time of his recent appointment.

Items of Personal Interest

R. W. Retterer has been appointed mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Cincinnati, Ohio. He was formerly acting mechanical engineer at this point.

J. J. Mellen has been appointed master mechanic of the Cincinnati Northern, with headquarters at Van Wert, Ohio, succeeding **W. R. Beck**, who has resigned.

C. H. Holdredge has been appointed district road foreman of engines of the Southern Pacific, with headquarters at Los Angeles, Cal., and **A. H. Hoffman** has been appointed assistant general air brake inspector at the same point.

A. R. Numbers has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe, with headquarters at Ottawa, Kans.

A. H. Oelkers has been appointed chief mechanical engineer of the St. Louis-San Francisco, with headquarters at Springfield, Mo.

B. M. Brown has been appointed assistant superintendent of motive power of the Southern Pacific, with headquarters at El Paso, Tex.

George H. Rusboldt has been appointed mechanical engineer of the Chicago Great Western with headquarters at Oelwein, Iowa. He succeeds **F. W. Stubbs**, who has resigned.

J. J. Callahan has been appointed acting master mechanic of the Delaware & Hudson at Carbondale, Pa.

G. E. Chatham has been appointed car foreman of the Atchison, Topeka & Santa Fe, with headquarters at Brownwood, Tex.

C. C. Cannon has been appointed fuel supervisor of the Chicago Great Western with headquarters at Chicago, Ill.

J. M. Nicholson has been appointed fuel conservation engineer of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kans.

W. H. Winterrowd has been appointed Assistant to the President of **Lima Locomotive Works** with headquarters at 17 East 42nd Street, New York. Mr. Winterrowd was born on April 2, 1884, at Hope, Ind. He attended the public schools at Shelbyville, Ind., and was graduated in 1907 from Purdue University. During his college vacation he was employed as a blacksmith's helper on the Lake Erie & Western, at Lima, Ohio, in 1905, and in 1906 he was a car and air brake repairman on the Pennsylvania Lines West at Dennison, Ohio. After graduation in 1907 he became a special apprentice on the Lake Shore & Michigan Southern, and in 1908 he went with the Lake Erie, Alliance & Wheeling as engine-house foreman at Alliance, Ohio. In 1909 he became night enginehouse foreman of the Lake Shore & Michigan Southern at Youngstown, Ohio, and in 1910 was made roundhouse foreman at Cleveland. Later in the same year he was promoted to assistant to the mechanical engineer of the Lake Shore. Since September, 1912, has has been with the Canadian Pacific, first as mechanical engineer and in 1915 he was appointed assistant chief mechanical engineer and in 1918 was appointed chief mechanical engineer, which position he held to the time of his appointment as above noted.

W. H. WINTERROWD

Mr. Winterrowd is active in the Mechancal Section of the American Railway Association, being a member of the General Committee. He is also active in the American Society of Mechanical Engineers. Together with E. H. Vaughan and Frank H. Clark, he contributed greatly to the success of the boiler code of the Society. Among the papers he has presented is a noteworthy article on refrigerator cars. He has taken particular interest in the Railroad Section of the A. S. M. E., serving as Vice Chairman of the Executive Committee last year, and is at present an active member of this committee.

OBITUARY

Francis J. Cole, until recently Chief Consulting Engineer of the **American Locomotive Company,** died January 11, 1923, at his winter home in California.

By Mr. Cole's death the railway field lost a man who was generally recognized as one of the leading locomotive designers of his day. From his eighteenth birthday, when he became an apprentice machinist in the Mount Royal shops of the Northern Central Railroad, Baltimore, Md., until his retirement, approximately one year ago, his whole life was devoted to this field.

Mr. Cole was the son of an English Episcopal clergyman, who came to the United States and settled on a farm in Virginia, Francis being a young boy at the time and one of several children. Farm life, however, did not appeal to him, and he became an apprentice machinist as noted above. After serving his time, he accepted a position as draftsman under Mr. William H. Harrison on the Baltimore & Ohio R. R. at Newark, Ohio. Being young, ambitious and continually seeking advancement he shortly left the Baltimore & Ohio to become a draftsman on the West Shore R. R. at Frankfort, N. Y., under Mr. R. H. Soule, S. M. P. John Player, Mr. Cole's immediate superior, was the Mechanical Engineer. Also it was here where Mr. Cole became associated with Mr. J. E. Sague, who was one of the other draftsmen and with Mr. W. F. Dixon, who was a special apprentice.

The impression, however, of his usefulness that he had left with the B. & O. at Newark was such that, after a short time of employment at Frankfort, he was offered the position as Chief Draftsman of the B. & O. at Newark, Ohio. Here, too, he further established his ability, resulting in his transfer to the Mount Clare shops as Chief Draughtsman. Later, about 1890, when Mr. G. B. Hazlehurst became General Superintendent of Motive Power, Mr. Cole was appointed Mechanical Engineer in charge of the design of all mechanical equipment, including cars and locomotives. His exceedingly efficient work in standardizing the design of both the locomotives and cars on this road attracted national attention. Also, while on the B. & O. he published a series of articles on locomotive design, which were widely used and generally recognized as the best data available.

FRANCIS J. COLE

In the course of time Mr. Dixon, who had been an apprentice on the West Shore during Mr. Cole's short employment with that road, had become Mechanical Engineer of the Rogers Locomotive Works at Paterson, N. J. In the fall of 1895, when Mr. Dixon accepted an offer to go to Russia to build a locomotive works, he recommended to Mr. Reuben Wells that Mr. Cole succeed him and in 1896 Mr. Cole became Mechanical Engineer of the Rogers Locomotive Works.

The Rogers Works was temporarily closed in 1899. During this time Mr. Cole accepted under Mr. Sague the position of Assistant Mechanical Engineer of the Schenectady Locomotive Works.

Later when the American Locomotive Company was formed, Mr. Sague, becoming Mechanical Engineer, immediately appointed Mr. Cole as his assistant, and later, when Mr. Sague became Asst. Vice President, he appointed Mr. Cole as Mechanical Engineer of the Company. This position was held by Mr. Cole until later in life, when wishing to be relieved of some of the arduous duties, he was appointed Chief Consulting Engineer. This position he retained until his recent retirement.

Mr. Cole was of the quiet unassuming kind, who never spoke of himself or what he did. He had a vein of persistence which generally led to getting his own way, reinforced by the fact that his own way was generally right. He was a close and thorough student with an inborn determination to arrive at exact facts in all his investigations; all resulting in his becoming internationally known as an eminent authority on the mechanical design and performance of the steam locomotive. His name is written high in the annals of American locomotive building.

His best known work was during his connection with the American Locomotive Company, when he was a leading factor in standardizing the locomotive designs and methods of the different plants which were organized under one management to form this corporation.

In the adoption of the superheater Mr. Cole took a prominent part. His work on "boiler ratios" was a radical departure from former methods, and today are universally used. He also will be remembered for his "four cylinder compound" of former days; and more recently as the designer of "Number 50,000," the Cole trailing truck and an innumerable number of details all tending toward refinement of design. He was a bold designer, though a safe one and could never be accused of fostering any "freaks."

He was a prominent member of the American Society of Mechanical Engineers, the American Railway Association, the American Society of Testing Materials and many others.

He left no children and is survived by Mrs. Cole, two brothers, Messrs. Arthur and Charles Cole of Baltimore, Md., and a sister, Mrs. Susan Thomas, also of Baltimore.

About two years ago he built a winter home in Pasadena, Cal., and within the past year retired from active business. For the past four weeks he had not been feeling at his best, though not thought to be seriously ill. However, after four days of more serious illness he passed away in his sleep at his winter home in Pasadena. He was a devoted husband, a true and loyal friend to those who were fortunate enough to know him intimately, and of a character whose life and example are only for the good.

The quiet persistence to which allusion has already been made manifested itself in many ways that were not intrusive and which gained for him the regard of many. Let an engineer but so much as hint that he was engaged upon a piece of work the results of which might be of value, and Mr. Cole never forgot the work or the man. It might be years between the meetings, but when the meeting did occur Mr. Cole was very sure to say: "By the way, have you ever done anything more about that matter of——?" For discussions along such lines, he always had all of the time there was available, and the quiet of his office with his insistent interest was well adapted to bring out all that there was of the best in a man. And it was not that he was altogether the absorbent in a conversation. He was quite as ready to lay the whole wide field of his experience open to his friends as he was to look to them to give what they had to him. Certainly he was a man whom it was a delight as well as a profit to have known.

Robert E. Adreon, president of the American Brake Company, and acting manager of the Southwest district of the Westinghouse Air Brake Company, died suddenly January 6, in St. Louis, Mo. Mr. Adreon was born in St. Louis, Mo., in 1876. He was the son of the late E. L. Adreon, who until his death some years ago, was also president of the American Brake Company. In 1903 he joined the Westinghouse Automatic Air & Steam Coupler Company, of which he subsequently became vice-president and general manager. He resigned in 1908 to enter the service of the Westinghouse, Church, Kerr & Co., contracting engineers. In 1911 he was appointed assistant general manager of the American Brake Company, later becoming vice-president and general manager. In 1919 he was elected president and general manager of the company, and continued in this capacity until his death.

Testing the Disease of Rust

A very complete 32-page illustrated book has just been issued on the subject of "Applying Science to Inhibit Rust." It treats the product NO-OX-ID as it has been successfully applied to the elimination of losses from rust and corrosion. The general thought of the book is not new, but its treatment of rust as a disease of metal and its scientific remedying of this difficulty is new and very interesting.

The book states: "A true rust inhibitor must possess two characteristics: First, it must cover the surface properly to exclude external 'corrosive elements.' Second, it must quench the tendency of the surface of the metal to corrosion. Add to these characteristics, easy application, wide range of utility and moderate cost and you have the ideal rust preventive."

It covers various considerations in rust prevention thoroughly even to the point of showing direct application of the commodity in the numerous phases of the iron and steel industry, in export service, for pipe lines and tanks, in railway and marine service, and in ice and refrigerating plants. Numerous interesting instances of savings "from watch springs to battle ships" are quoted.

Copies of this book may be obtained from the Dearborn Chemical Company, 332 South Michigan avenue, Chicago.

Chilled Iron Car Wheels

Bulletin No. 134 of the Engineering Experiment Station of the University of Illinois, entitled "An Investigation of the Properties of Chilled Iron Car Wheels. Part II. Wheel Fit, Static Load and Flange Pressure Strains. Ultimate Strength of Flange," by J. H. Snodgrass and J. H. Goulder, has recently been issued.

The investigation reported in Bulletin No. 134 includes the determination of the strains which may occur within a car wheel, and a study of the limitations of present designs, with the object of improving the chilled iron car wheel and making it more satisfactory under present and future service requirements. The work was done under a co-operative agreement between the Association of Manufacturers of Chilled Car Wheels and the Engineering Experiment Station of the University of Illinois.

The first part of the present bulletin contains a report of an extension of the tests previously reported in Bulletin No. 129—"An Investigation of the Properties of Chilled Iron Car Wheels. Part I. Wheel Fit and Static Load Strains"—and discusses the strains existing in a 33-inch 840-pound Arch Plate Wheel when subjected to the combined effect of mounting, static load, and side thrust pressures; the remainder of the bulletin deals with a series of tests made to determine the ultimate strength of the car wheel flange. This latter series of tests is concerned with thirty-three wheels having flanges of various shapes and includes specimens representative of both new and worn wheels. Among them will be found specimens of wheels with the standard contour recommended by the Master Car Builders' Association, and others with the flange suggested by the Association of manufacturers of Chilled Car Wheels to replace the present M. C. B. standard flange. In addition, there were tests made on wheels with flanges ground to represent various stages of wear, and also on two wheels which were worn out in service.

Copies of Bulletin No. 134 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

Locomotive Starter

A booklet descriptive of the Street locomotive started has recently been issued by Clement F. Street, Greenwich, Conn. It is illustrated with drawings and photographs showing the application of the starter as applied to the trailing truck axle of the different types of locomotives.

Railway and Locomotive Engineering

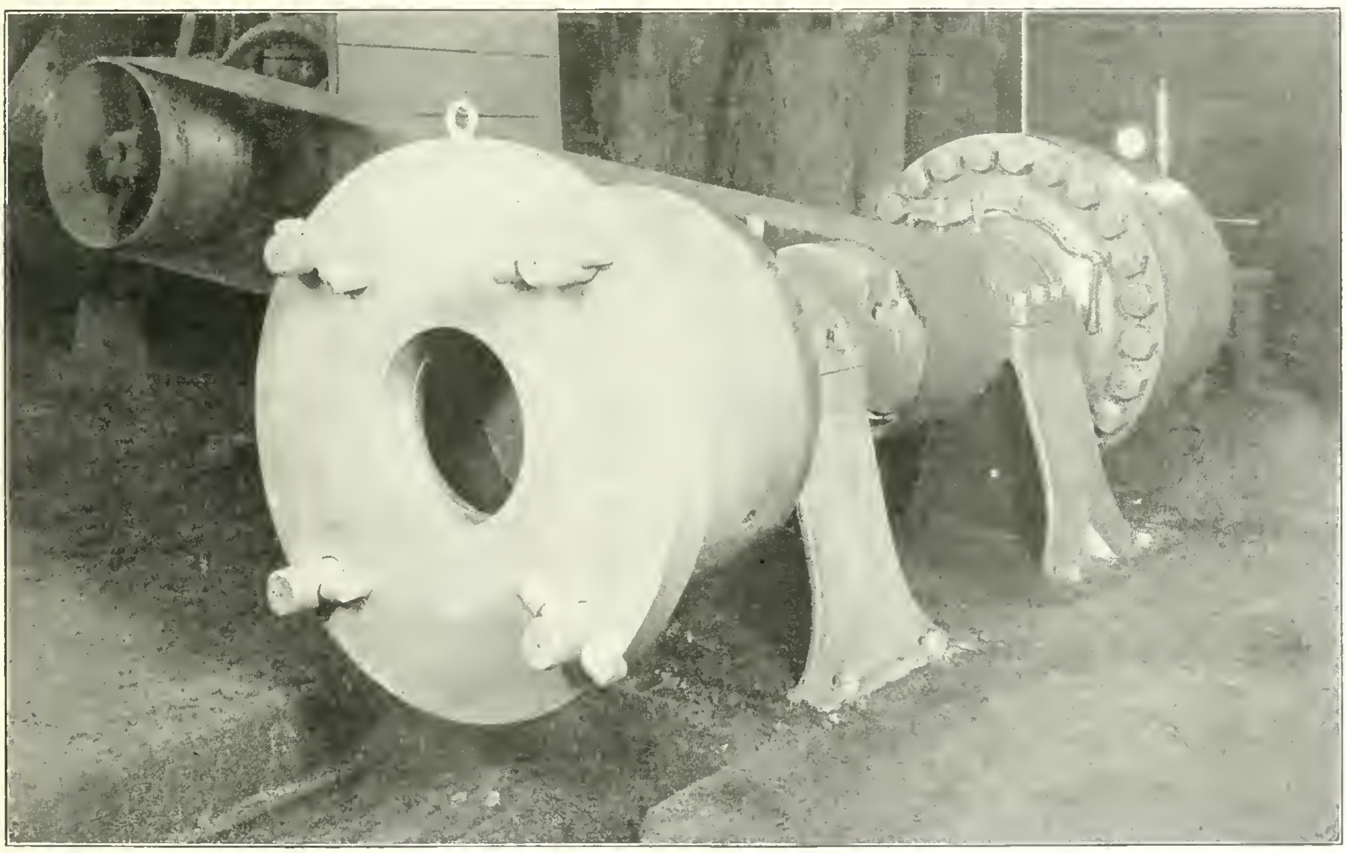
A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXVI 114 Liberty Street, New York, March, 1923 No. 3

New Patented Process for Steel Casting

Developed by William McConway, Pioneer Manufacturer of Automatic Car Couplers

After many years of study and investigation, Mr. William McConway, president of the McConway & Torley Co., Pittsburgh, has perfected a machine for the casting of steel ingots by the centrifugal process. Steel ingots up to 1,600 lbs. in weight have been cast in this machine. Steel of excellent structure has been produced and has many applications, not the least interesting of which has been its reduction to wire. Mr. McConway's invention differs from other centrifugal methods in that the centrifugal action is on a vertical instead of a horizontal plane.

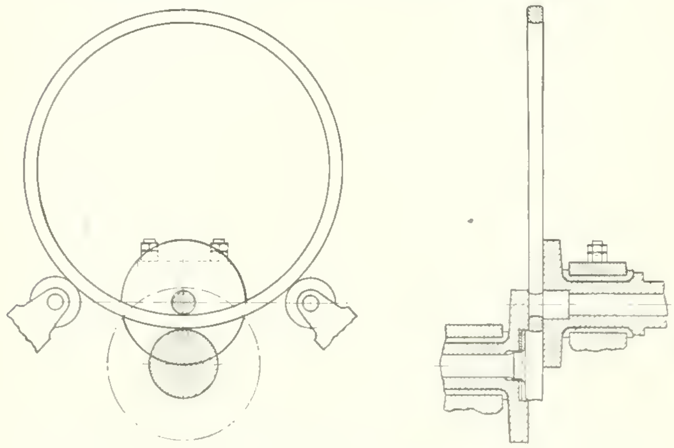


MACHINE FOR CASTING STEEL UNDER PRESSURE BY THE CENTRIFUGAL PROCESS IN A VERTICAL PLANE

The illustrations give details of the McConway casting machine. In operation, the only stationary parts are the bearings and the hydraulic nipple. The machine is motor driven and attains a peripheral speed of 65 ft. per second. The process consists first in placing in position at the casting end the matrix, which determines the diameter of the disk or ingot. The fore plate, containing an aperture for the pouring spout, is then locked in place and the charging scaffold and scales are drawn into position. The molten metal is poured into mould through the opening shown in the first plate or disk covering, and when sufficient metal has been poured for the sized casting determined upon, it is then placed under a hydraulic pressure by the horizontal movement of a piston under the other end of the machine to the right of about 500 pounds per square inch, which pressure is maintained for a space of about 11-12 minutes, from the time of the pouring of the metal until the removing of the casting from the mould.

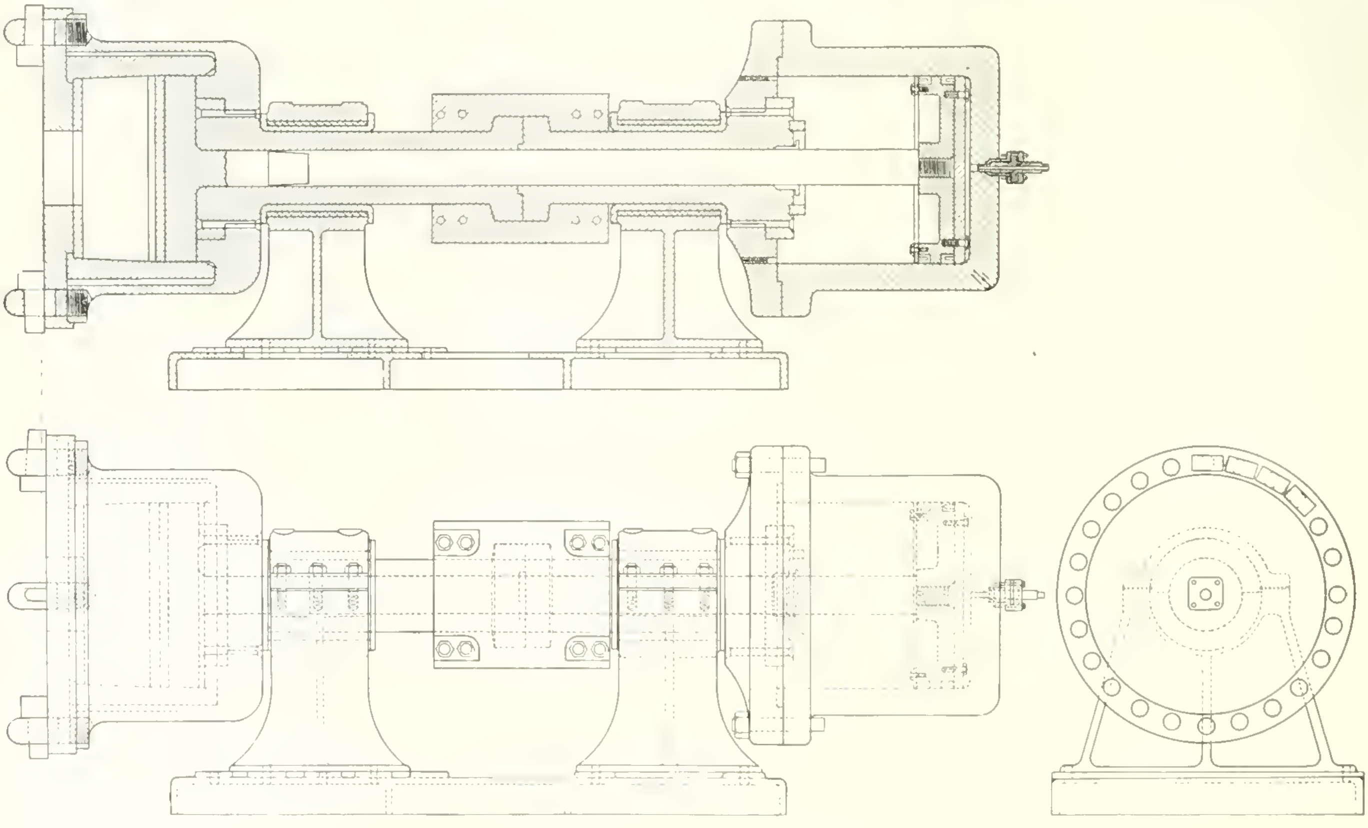
The casting is then placed in another furnace or soaking pit where it is brought up to a very high temperature almost to the fusing point. It is then removed and placed under hydraulic press and subjected to a pressure of over 2,000 tons which finally completes the operation.

A steel disk made in this machine is shown in one of the illustrations. In the center is a small projection that



PLAN OF SPECIAL ROLLING MILL EMPLOYED TO REDUCE AN INGOT TO A BILLET OR RING SIZE

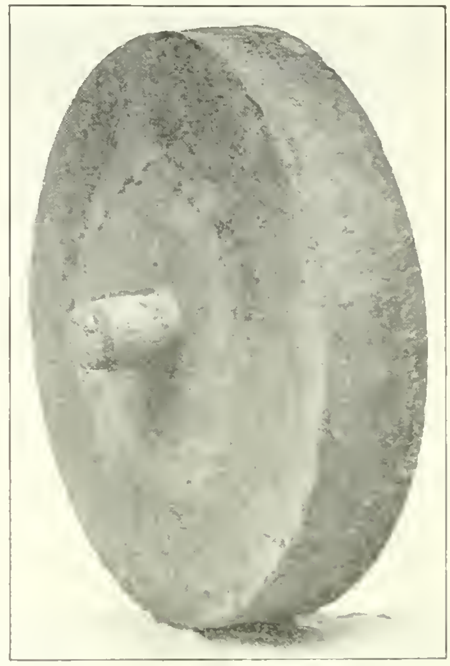
has come out through an opening which permits the slag or impurities of the casting to be formed as a result of the pressure, and this disk is then removed so that the entire casting is of great density and hardness and entirely free from air pockets, sponginess, or other impurities of relatively good castings made by other processes.



DETAILS OF THE McCONWAY STEEL CASTING MACHINE

While we are justly proud of the great development in equipment of American railways we are sometimes remiss in giving proper credit to those who have contributed most liberally to this wonderful result.

We live in the steel age, and when we speak of steel we think of the steel kings, Carnegie, Schwab and Gary, and quite properly so with respect to the development of the great steel industry as a whole, but when we come



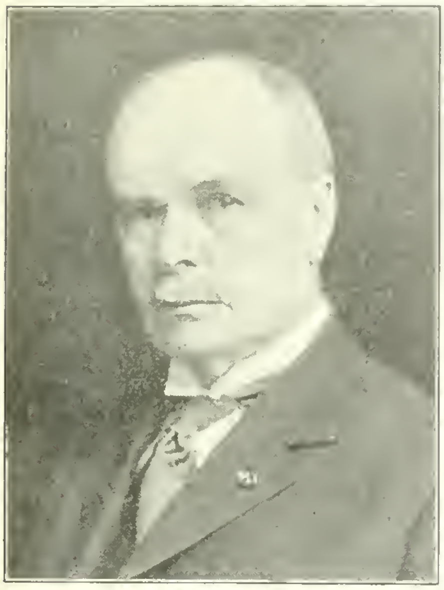
STEEL DISK MADE IN McCONWAY CASTING MACHINE

to the introduction of steel into the design and manufacture of railway equipment, cars and locomotives, we find that the real pioneers, who by their untiring energy and great sacrifice developed some of the most important parts of cars and engines parts that are the life of the completed unit—have not been given proper credit for their achievements.

The M. C. B. Coupler

As an illustration let us take the master car builders' coupler. Many of the younger generations of railway men do not know of its origin or history, while many of older ones are so engrossed in other things that many of the incidents in connection with its development have passed from their minds, and few actually give the matter more than a passing thought.

Brushing aside a great mass of detail, essential to a complete historical review of the various stages of development, we may start at the point in 1877 when Mr. McConway took hold of E. H. Janney's drawings and in co-operation with the progressive railway officers, applied himself diligently to a solution of what was then a most complex problem, in fact the use of the automatic vertical plane coupler was so successfully opposed from many sources, that it seemed for a time that the "Link and Pin" was destined to retain almost unquestioned leadership. As evidence of the settlement at that time, it might be interesting to note that at the annual convention of Yard Masters in 1877, the Safford draw bar (link and pin) was endorsed by them and by the end of 1879 there was something like 90,000 installations of this device on 167 railroad lines, as it also complied with the master car builders' requirements for standard draw bar.



WILLIAM McCONWAY

The link and pin coupler however was slated to go and some of those who opposed its immediate abolition by law, were not so much concerned in its permanent retention, as they were in trying to work some of the wrinkles out of the vertical plane automatic coupler offered in its place, and thus be reasonably safe in making the change for which there were quite a general demand from train men and the public.

Following the adoption of the M. C. B. Coupler in 1888 there was for several years quite a variety of automatic couplers on the market, quite a few were made of malleable iron that failed to withstand the buffing shocks of heavy service, others developed defects in design or weakness in operation and as a result of various causes the number which survived was comparatively few, and for some years past the M. C. B. Standard Coupler may be considered as the outgrowth of the original Janney Coupler manufactured by Mr. Wm. McConway first in 1882 and who to-day manufactures the Penn. and A. R. A. type "D" couplers for freight cars, the Pitt. and type "D" couplers for passenger cars and other railway devices.

It seems quite satisfactory and proper to here make acknowledgment of the terms "Vertical Plane" and "M. C. B. Coupler."

For the first title or designation we are indebted to Mr. John W. Cloud who was one of the most active and progressive men who had to do with working out the details and finally adopting an automatic coupler embracing this principle, and when the matter was under discussion as to the merits of various link controlling devices; combination of links and hooks; "harpoon," or arrow head type; solid draw bar hooks which coupled torsionally; with the "Miller" and the "Janney" as the two used on passenger equipment to the exclusion of all other designs, Mr. J. W. Cloud made the remark that the only automatic couplers which so far had given evidence of practicability by successful service were those in which the contact faces of the couplers came together on a "vertical plane." The phrase "took" and hence the "Miller" and "Janney" became known as "vertical plane couplers."

To Godfrey Rhodes belongs the paternity of the "M. C. B." as applied to couplers. And it was he who following long discussions as to the proper name finally said "If you are unwilling to designate the type which has been selected as the 'Janney' type, then call it by any other name which will make the identification effective. Call it the 'Master Car Builders Coupler,' but call it anything so that the name will identify the thing which has been adopted." And the term "M. C. B. Coupler" was given birth.

Another man who deserves great credit for his fidelity and abounding faith even in the face of almost universal opposition and who never hesitated to submit the soundness of his own conclusions was Edward B. Wall of the Pennsylvania Railroad.

During the intervening years 1882 to 1923 the McConway & Torley Company have probably furnished the railways of the United States more car couplers and similar parts than any other company in the railway supply business.

Mr. Conway, Sr., having safely guided the company's business affairs through lean years as well as more prosperous ones, has for some years past gradually transferred much of the more exacting detail work to younger shoulders, in fact Mr. Wm. McConway, Jr., has for some years and is now the active head of this company. Mr. McConway, Sr., still interests himself in the business and in the improved art of steel manufacture as indicated by his most recent contribution to that art, the perfection of a machine or mold for casting ingots of sufficient size to compete profitably with current methods.

Specifications for Industrial Peace

At the February meeting of the New York Railroad Club, held in the Engineering Society Building on Friday, February 16, a most interesting lecture was delivered by Mr. E. K. Hall, vice-president of the American Telephone & Telegraph Company, in the course of which the speaker clearly outlined in detail the system followed by that company in dealing with its employes and which has not only proven satisfactory alike to both employers and employes (except to a few disgruntled soreheads or incompetents in each class that should be eliminated) but has resulted in materially increasing efficiency of all, the income of the company, and generally beneficial.

The lecture, which occupied about one hour and a half, was most interesting throughout, the plan being so ably presented by the speaker as to leave no doubt in the minds of his hearers as to principles involved and results obtained.

Making due allowance for the difference in conditions on our railways and large manufacturing concerns, the principles enunciated by Mr. Hall and which are the basis of his specifications, are equally applicable to these, and if introduced by them would no doubt result in gratifying results. Copies of Mr. Hall's address should be in the hands of everyone interested in this problem.

The Stresses in Straight and Curved Track

A Paper Presented at the Annual Meeting of the American Society of Civil Engineers

Among the interesting papers presented at the annual meeting of the American Society of Civil Engineers, which was held in New York, January 17, 18 and 19, was one of more than ordinary interest to railway men, the third progress report of the Committee on Stresses in Railway Track.

Since its organization in 1914, the Committee has been co-operating with the Special Committee on Stresses in Railroad Track appointed by the American Railway Engineering Association, the membership of the two committees being the same with the exception of one member of the American Railway Engineering Association who does not hold membership in the American Society of Civil Engineers, and the work has been carried on as that of one committee. This report is presented simultaneously to the two Societies and to the American Railway Association, which also has been co-operating in the work for the past four years.

As stated in the earlier reports, the Committee has felt that an adequate report on stresses in railroad track must be based largely on experimental data, derived from extensive tests on standard railroad track, and that, in view of the complexity of the action of track under load and the variability of the conditions to be found in track and load, the work of conducting experiments and reducing the data would necessarily require much time and effort. The development of methods of conducting the tests and the work of devising the instruments and apparatus have involved a considerable expenditure of time, effort and money.

It has been recognized that in obtaining data on the action of track under variable conditions of both track and load, great refinement of method was not possible and that it was important to make tests, under conditions of railroad service as nearly normal as possible, also utilizing of course the data of laboratory investigations where conditions would not warrant satisfactory experiments in the field.

The first progress report of the Committee was published in 1918, and the second in 1920.

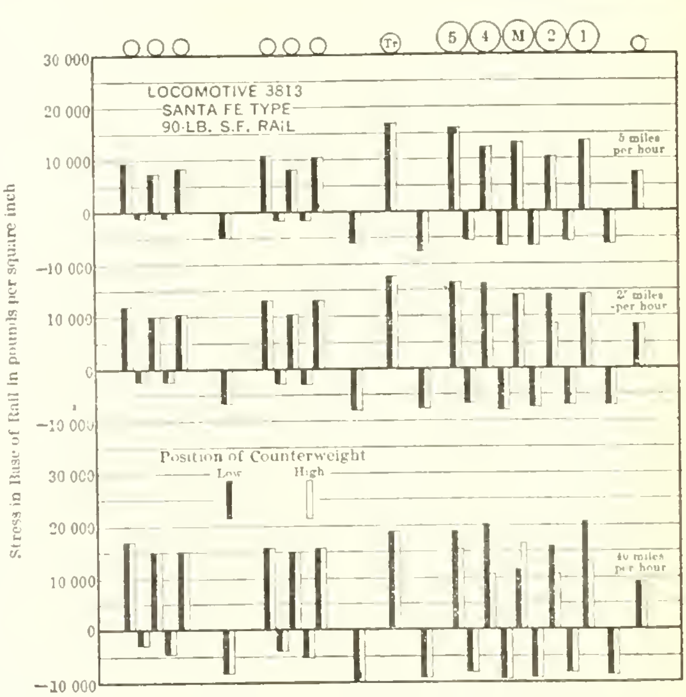
The work reported herein includes tests on straight track and curved track. In the tests on straight track, consideration was given to the effect of counterbalance, the effect of speed and the combined effect of speed counterbalance, and the lateral bending moments and stresses in the rail. In the tests on curved track are taken up the general action of curved track as the locomotive traverses the curve, the magnitude of the vertical bending stresses in the rail and the corresponding vertical loads producing them as contrasted with the normal loads, the lateral bending moments and stresses under the several wheels, the distortion of the alignment of the curves, and the general effect of speed, degree of curve, and super-elevation. The tests were conducted on the Illinois Central Railroad, the Delaware, Lackawanna & Western Railroad, the Atchison, Topeka & Santa Fe Railway and the Southern Pacific Railroad. In the tests, thirteen locomotives of eight distinct types were used. In several types there were variations in the design of the locomotives of the different railroads. The report is presented under the heads of Tests in Straight Track and Tests on Curved Track.

Conduct of the Tests and Reduction of the Data

The methods used in the tests of track were the same as those used in the tests described in the first and second progress reports. Eight stremmatographs were used simultaneously. Four stremmatographs were placed on one rail between ties at distances

DATA OF THE TRACK

Track	Location	Rail section	Date of laying	Tie-spacing	Depth of ballast Inches	Grade percentage	Gage	Super elevation of outer rail	Speed of super-elevation, in miles per hour
Tangent	Ribera, N. Mex.	90-lb. S. F.	1917	18	12	—1.40	4.8½	..	..
6° curve	Ribera, N. Mex.	90-lb S. F.	1917	18	10	—1.18	4.8⅞	4.7	35
10° curve	Ribera, N. Mex.	90-lb. S. F.	1920	19	10	—1.02	4.8⅞	4.7	27
Tangent	East Fort Madison, Ill	85-lb. Am. Soc C E	1906	20	22	0.0	4.8⅝	..	..
10° curve	Fort Madison, Iowa	90-lb. S. F	1920	21	14	0.0	4.9⅛	2.0	17
Tangent	Dover, N. J.	105-lb. D. L. & W	1915	22	12	—0.55	4.8¾	..	..
4° curve	Dover, N. J.	105-lb. D. L. & W.	1919	22	18	0.63	4.8⅞	3.7	37
6° curve	Mt. Tabor, N. J	92-lb. Frictionless. / 101-lb. D. L. & W.	1914 / 1915	22	6	—0.84	4.8¾	8.5	46
7½° curve	Paterson, N. J.	105-lb. D. L. & W	1919	20	9	0.0	4.9⅛	6.4	36
10° curve	Bealville, Cal.	90-lb. A. R. A. A	1921	22	5 on old grade	2.00	4.8⅞	4.4	26
10° curve	Cajon, Cal.	90-lb. S. F.	1920	18	10	1.80	4.8½	5.4	29
7° curve	Murphysboro, Ill.	90-lb A. R. A. A.	1914 / 1919	20	12	0.0	4.9	3.7	28
14° curve	Champaign, Ill.	85-lb.	1903	19	Cinder	0.0	4.8⅞	3.8	20



STRESS ON STRAIGHT TRACK AT HIGH AND LOW POSITION OF COUNTERWEIGHT, HEAVY SANTA FE TYPE apart approximately equal to the average spacing of the drivers of the locomotive used on the test, and the other four instruments directly opposite on the other rail. The driving mechanism used rotated the discs of all the instruments simultaneously. The correlation of a point on the record of one of the discs with the point of any other disc at the same moment was possible. As the locomotive passed the test section a record of the strains in the rail was made on each instrument. The passage of each wheel of one side of the locomotive and tender thus was recorded on four instruments and each wheel of the other side on four other instruments. A run then gave records of what happened under one pair of wheels on eight instruments, and as each instrument holds two discs, sixteen records in all were made. As usually operated, a disc would hold the records of four runs. Fresh discs would then be inserted.

Tests on Straight Track

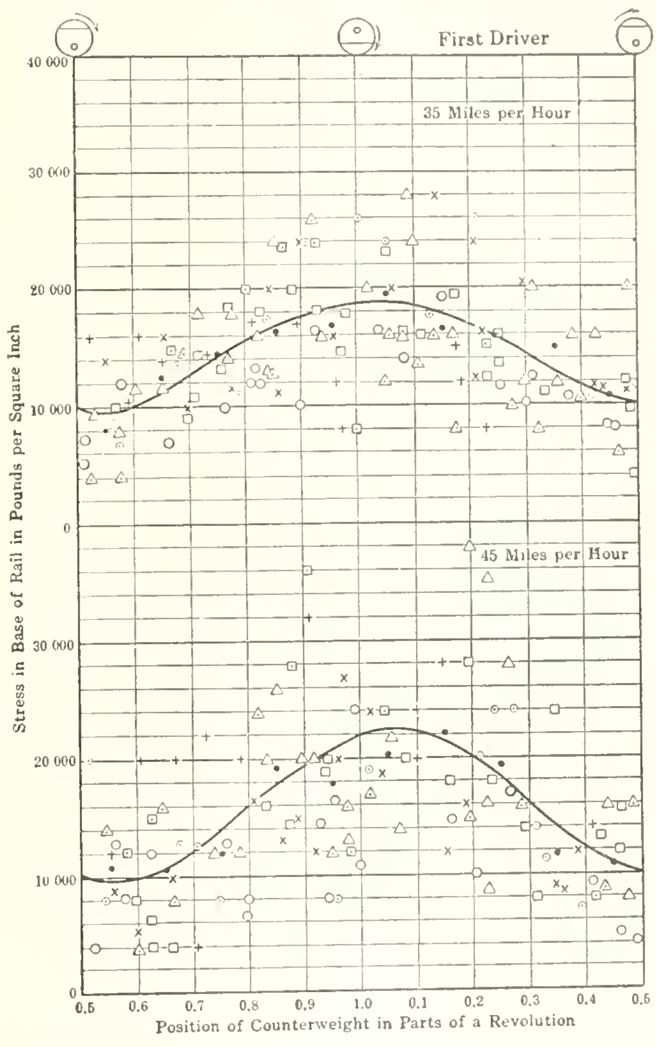
The tests on straight track, although made for the purpose of supplying a basis of comparison with results on curved track, furnish considerable additional information on the action of straight track, particularly on the effect of speed and counterbalance with several types of locomotives.

To determine the stiffness of track and the value of the modulus of elasticity of rail support, *u*, measurements of track depression under the truck of loaded cars were made.

The results of the measurements were arranged in tables which give the average or mean values of the stresses in base of rail under the locomotive wheels found in the tests, and also the values at the high point and the low point of the counterweight. The calculated stresses under the nominal static wheel loads are also given. The calculations are based on the method of analysis given in the first progress report, and the value of *u* from the tests of track depression was used. It will be noted that the calculated values of the stresses for static loads in general do not differ greatly from the observed values at a speed of 5 miles per hour. Where there is a noticeable difference, it seems probable that the actual distribution of load among the individual wheels is not the same as the assumed distribution. It is found, however, that the average of the calculated stress under the several wheels of the locomotive is almost exactly the same as the average of the observed stresses under the wheels at a speed of 5 miles per hour, the greatest difference in all the tests being about 6 per cent.

The data indicated that the highest stress in rail under the main driver in all the locomotives except the Pacific type of the Delaware, Lackawanna & Western Railroad and the Balanced Compound Prairie type of the Atchison, Topeka & Santa Fe Railway occurs when the counterweight is up. For several of the locomotives, a calculation for the counterbalance in the main driver indicated that, in many cases, the high stress may be expected to occur when the counterweight is down, if the method of calculation is that so generally used of neglecting the effect of the plane of motion of the main rod and other outside rotating parts not being coincident with the plane of motion of the counterweight and wheel and rail, whereas, the opposite condition may be shown by the results. It is evident from the discussion of this subject in the second progress report that a proper consideration of the relative positions of the plane of the rotating parts and of the wheel will account for this seeming contradiction.

In general, for all the locomotives except the Light Santa Fe type, the stresses attributable to counterbalance at the highest speeds run, which in some cases were greater than the scheduled maximum speed allowed for the locomotive, are less than 5,000 lb. per sq. in. and, in most cases, considerably less than this. The counterbalance effect at the highest speeds used may be said generally to be not more than 30 or 40 per cent of the average stress in rail at 5 miles per hour; in some few cases, it runs higher; but, in most cases, it is lower. A counterbalance effect of 30 per cent will not be considered to be excessive, and the



OBSERVED VALUES OF STRESS ON STRAIGHT TRACK, LIGHT SANTA FE TYPE

only question is whether the scheduled speeds are likely to be exceeded very much. It is seen that an increase of speed of 25 per cent will increase the counterbalance effect by 56 per cent of itself, and an increase of speed of 41 per cent will double the counterbalance effect. It is evident that great care must be exercised to prevent the scheduled limits of speed being exceeded very much if the stresses due to counterbalance are to be kept within moderate bounds. It is also clear that every care should be taken in the design, construction and maintenance of the proper counterbalance, and checks should be exercised to insure that the conditions of counterbalance are known with certainty, as it has frequently happened that the counterbalance effect has varied from the reported or expected condition. Attention should be given to the main driver and a careful determination made of the effect of the outside rotating parts not being in the plane of the wheel and counterweight.

In the locomotive for which the weights and positions of rotating parts seem to be accurately known, the value of the additional stress due to counterbalance, calculated by the use of the calculated vertical dynamic augment, agrees fairly closely with the observed counterbalance stress. For the main driver, the difficulties are increased, but accurate knowledge of the position of the several outside rotating parts with reference to the plane of the driver itself should permit a fairly close determination of the counterbalance stress under this driver. Any method of design or improvement in materials that will help to keep small the counterbalance effect should be welcomed by both the Mechanical and the Engineering Departments.

Effect of Speed and the Combined Effect of Speed and Counterbalance

With the exception of the Light Prairie type and the Light Santa Fe type, it will be seen that the general increase in stress in rail under the drivers due to speed alone in changing from 5 miles per hour to the highest speed used in the tests ranges from 15 to 27 per cent, which may be called a moderate and allowable speed effect. With the same exceptions, the maximum speed effect under any one driver ranges from 24 to 30 per cent. For these locomotives and these

Speed, in miles per hour.	Position of counterweight.	Trailer 2	Trailer 1	Driver Number 5	Driver Number 4	Driver Number Main.	Driver Number 2	Driver Number 1	Front truck wheel.
5	Mean value	9 200	8 900	9 500	11 400	11 100	11 900	11 900	11 700
25	Up	....	....	9 000	10 500	15 500	11 000	12 500	......
	Down	....	....	12 500	14 500	9 000	15 000	15 000	......
	Mean value	10 400	10 100	10 100	12 400	12 200	13 000	13 900	12 400
40	Up	....	....	10 500	9 500	20 000	11 000	12 500	......
	Down	....	....	14 500	15 500	10 000	16 500	16 500	......
	Mean value	11 500	11 100	12 400	12 800	12 900	14 000	14 900	13 800
Calculated stress under static load.		8 700	7 500	12 600	9 500	10 000	11 800	14 500	8 600
Calculated additional stress due to counterbalance at 40 miles per hour		....	....	+3 700	+3 600	-2 800	+3 600	+3 700	......

STRESSES WITH DOUBLE TRAILER TYPE, SANTA FE ON CURVES

PRINCIPAL VALUES OF INCREASE IN STRESS IN RAIL AT A GIVEN SPEED OVER THE STRESS AT 5 MILES PER HOUR

The Increase is Given in Percentage of the Stress at 5 Miles per Hour.

Type of locomotive	Drivers: Speed alone: General value	Drivers: Speed alone: Maximum under one driver	Drivers: Combined speed and counterbalance: General value	Drivers: Combined speed and counterbalance: Maximum under one driver	Trailer	Tender wheels: General value	Tender wheels: Maximum under one wheel
Atchison, Topeka & Santa Fe Railway:							
Pacific, 60 miles per hour	27	30	53	53	15	75	93
Balanced Compound Prairie type, 50 miles per hour.	15	26	30	43	29	50	87
Mountain, 60 miles per hour	20	30	35	50, 55	10	40, 60	110
Light Santa Fe, 45 miles per hour	40	77	105	190	10	25	35
Heavy Santa Fe, 40 miles per hour	18	28	50	80	15	75, 70, 50	110
Delaware, Lackawanna & Western Railroad							
Pacific, 60 miles per hour	20	24	42	59	14	45	57

tracks, therefore, the increase in stress in rail due only to the change in speed noted may be said generally to be less than 35 per cent.

For the combined effect of speed and counterbalance for the same locomotives for the maximum speed used, the range of general total increase in stress in rail is 30 to 53 per cent, and the maximum increase under any driver ranges from 43 to 80 per cent. The stresses in rail at the maximum range from 20,000 to 29,000 lb. per sq. in., in the three sections of rails used. It should be borne in mind that these stresses are the averages of the stresses in the two edges of the base of rail, and, also, that they do not take into account the variations from the average, which are bound to occur, nor the effect of speeds higher than those normally used. It should be remembered also that the track was substantial track in good condition and that the locomotives were of good design and in good working order.

Stresses at the Two Edges of the Base of the Rail

In the two preceding progress reports, reference was made to the frequent and common lateral bending of the rail in straight track, and it was shown that the stresses due to such bending attain considerable magnitude. The data of the tests described in this report give added information on the subject. The data shows considerable variation between the stresses at the two edges. The stress at the outer edge of the base of rail is quite frequently 33 per cent or more greater than the mean stress in base of rail, in a few cases reaching an excess of 50 per cent or more, and this holds true throughout the revolution of the driver. A stress at the inner edge 33 per cent greater than the mean stress and even more was found, although less frequently. This means that in these cases the stress at one edge of the base is twice as much as that at the other, or more.

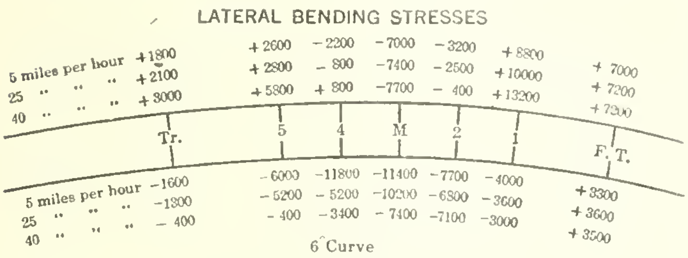
Results of Tests on Curved Track

The mean stress in the base of rail (the average of the stresses observed at the two edges and generally hereafter called the vertical bending stress), may be taken as representative of the bending of the rail in a vertical plane, or, more strictly of the bending in a direction normal to the inclination of the track, the two effects being practically identical for the superelevation of the track used in the tests as the cosine of the angle of inclination is very close to unity. Although stresses in rail are not exactly proportional to the loads when the same total load is differently distributed among the several wheels or differently divided between the two rails, yet, when the differences are not great, the sum of the stresses in the rail under all the wheels will generally not differ greatly for different divisions or distribution of load, and summations of the stresses for each rail may be useful for making comparisons and in checking the action of the locomotive and track.

For the lower speeds, it is seen that the division of stress between the two rails (and presumably also the division of load) for the Pacific type on the 4 deg. and 7½ deg. curves of the Delaware, Lackawanna & Western Railroad and the Mountain type and Heavy Santa Fe type on the 6 deg. and 10 deg. curves of the Atchison, Topeka & Santa Fe Railway agree very closely with the ratios calculated from the inclination of track and centrifugal force, thus confirming the analysis. The stresses observed under the Mikado type on the 4 deg. curve at the lower speeds give ratios which are much closer to unity than the calculated ratios; it is not known why these differ; for the 7½ deg. curve the agreement is close. The Pacific type of the Atchison, Topeka & Santa Fe Railway, on the 10 deg. curve, with a super-elevation of 2 in., gives ratios of observed stresses which vary from unity by an amount that is about twice as great as the calculated ratios. It appears from this that, for slight super-elevation, curvature alone gives an effect in changing the division of load between the two rails greater than that found from the inclination of track and the centrifugal force. Evidently, there is some transfer of load by other means, possibly the action of the equalizing levers.

For the higher speeds, above those corresponding to the speeds of super-elevation, more variation in the results are found.

It is evident that the changes in vertical bending stresses and in vertical loads at the several drivers are very marked and that important additions to the bending moments in the rail and in the bearing pressures at



Heavy Santa Fe Type Locomotive 3813
Superelevation 4.7 in. for 35 miles per hour

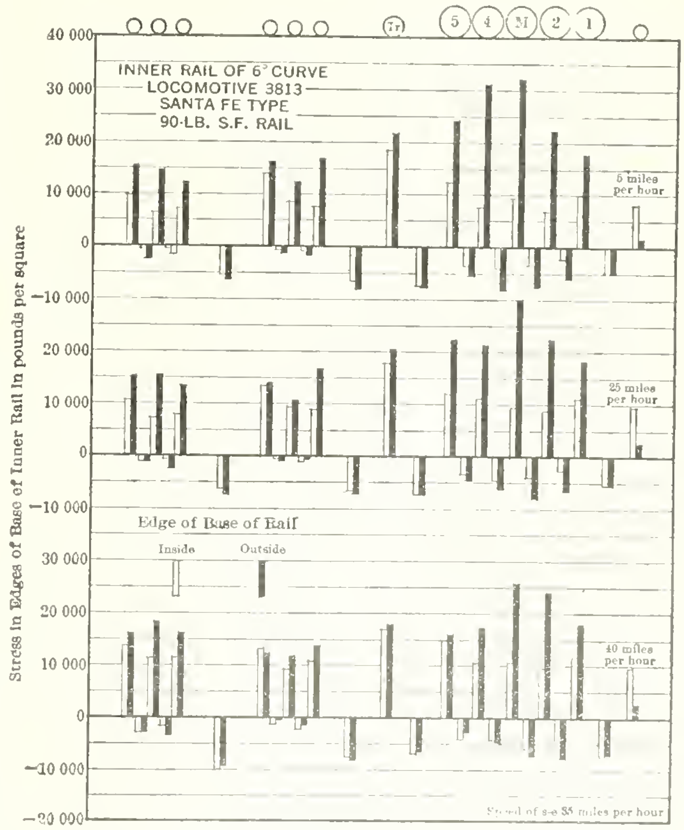
the top of the rail are found on curves. The increased stress in the inner rail under certain drivers is greatest at the low speed, but even at speeds two-thirds that corresponding to super-elevation increases of stress of 75 to 85 per cent of the increase found at the low speed were common. At the higher speeds, the special increase in load at the one driver vanishes, and the distribution among the several drivers is much the same as would be expected from a consideration of transverse inclination of track and centrifugal force, except that the vertical bending stress in the outer rail under the outer front driver is very great at the high speeds.

It is seen that for all the curves the relation of the average of the vertical bending stresses under all the wheels of a locomotive on the inner rail to the corresponding average of the stresses in the outer rail, taken as a measure of the bending of the rail in a vertical plane, in the main conform fairly closely to what may be expected from the analytical consideration of the transverse inclination of the track and the centrifugal force, as far as the locomotive as a whole is concerned. The principal variation from this conformity to analysis is the Pacific type locomotive on the 10 deg. curve having a super-elevation of 2 in.

The outstanding result of the foregoing study of vertical bending stresses on curved track is the variable distribution of load among the drivers, and, particularly, the greatly increased loads found on some of the drivers beyond that normally expected. These high loads occur principally on the inner rail and are most marked at the low speed, although high values were found in a number of cases at speeds two-thirds that corresponding to the super-elevation. Loads ranging up to 100 per cent in excess of the normal load were found with several of the locomotives. These excessive loads produce high stresses in the rail, but more important still they give very high bearing pressures on the rail. It is a well known fact, of course, that the inner rail of curves suffers greatly from the high pressure on it. The bearing pressures on the rail on straight track constitute a serious problem, and the conditions on the curves seem to be far worse than they have been thought to be. As the bearing pressures found are considerably higher under some of the wheels than those which ordinary analysis of the effect of transverse inclination of track and centrifugal force would predict, it would seem well to have a study made of the action of the equalizing levers and the springs on curved track to try to find the cause of the concentration of load, and to attempt to modify the design so as to obviate such gross inequalities.

Lateral Bending of Rail on Curves

The data shows the magnitude of the lateral bending stresses in the outer and inner rails under the several wheels of the locomotive and tender at the speeds at which tests were made, the stress being given in pounds per square inch, for the tests at Ribera, N. Mex., Fort Madison, Iowa, and Dover, Paterson and Mount Tabor, N. J. This lateral bending stress is the stress by which the stress at one edge of the base of the rail exceeds that at the middle of the base of rail; its magnitude is found by taking one-half the difference between the stresses at the inside and outside edges of the base of rail. The sign in front of the stress is indicative of the nature of the lateral bending of the rail; a positive sign indicates that the bending acts to increase the curvature of the rail, the negative that the bending tends to straighten the rail. The signs apply alike to both outer and inner rail. A positive bending in the outer rail at the point of contact



STRESSES AT THE INSIDE AND OUTSIDE EDGES OF THE BASE OF THE INNER RAIL OF A 6 DEGREE CURVE HEAVY SANTA FE TYPE

of a wheel implies an outward thrust against the rail at the given point; a positive bending in the inner rail implies that a lateral pull on this rail acts toward the outer rail. The diagrams give important information on the presence and nature of lateral forces and the manner of the lateral bending in the rail. Some of the outstanding features may be noted, as follows:

The lateral bending in the outer rail, under the wheels of the front truck, is found to be always positive (indicating an outward thrust) and it is generally positive also in the inner rail. This is true at all speeds. It indicates that the flanges of the outer wheel of the front truck always have an important part in changing the direction of the locomotive.

In a locomotive having two-wheel front trucks the lateral bending of the outer rail at the outer front driver is positive at all speeds, with the exception of the Mikado type on the 6 deg. curve, where the superelevation is 8.5 ins. With locomotives having four-wheel leading trucks, the bending of the outer front driver is generally negative at the low speed, becoming positive at the higher speed, with the exception that it remains negative in the case of the Pacific type locomotive on the 7½ deg. curve.

The outer rear driver gives a positive lateral bending in the outer rail (outward thrust on the rail) at all speeds, the one exception being the Pacific type locomotive on the 4 deg. curve at a speed of 5 miles per hour.

At low speeds, all the other drivers generally give negative bending in both inner and outer rail, tending to straighten the rail. The principal exception is that the bending moment under the inner fifth driver of the Santa Fe type locomotive is sometimes positive.

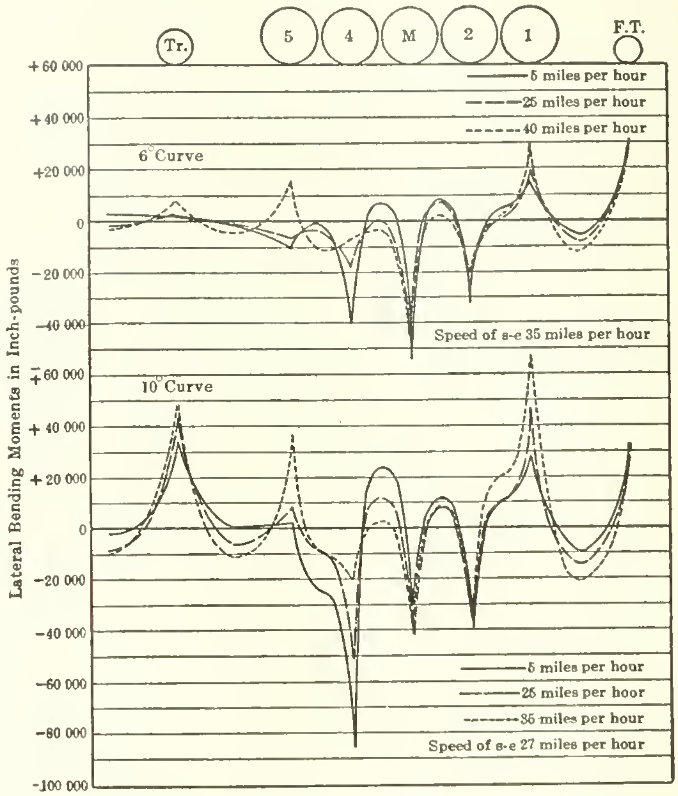
An increase of speed results in an increase of lateral bending in the outer rail, decreasing the value of the lateral bending stress if the bending is negative and increasing the stress if it is positive.

An increase of speed results in a decrease in the lateral bending in the inner rail, the numerical value of the lateral stress decreasing when the bending moment is negative and increasing when it is positive.

When the stress due to lateral bending is combined with that due to vertical bending, it will be seen that the resulting stress may be very great. This is the more marked because the high lateral bending stresses generally occur under wheels giving very high vertical bending stresses, much greater than those developed on straight track. Thus, for example, at the outside edge of the base of the inner rail of the 10 deg. curve under the fourth driver of the Santa Fe type locomotive, at 5 miles per hour, the stress is the sum of 23,500 and 29,200, resulting in a stress of 52,700 lb. per sq. in. This value is the average of a large number of runs; not infrequently stresses several thousand pounds greater than this were found, indeed, one of 75,000 lb. per sq. in. was recorded. It may be added that the value of the lateral bending stresses under many of the wheels ranged from 40 to 100 per cent of the vertical bending stress under the same wheel.

The general trend of the combined bending moments under and between the several wheels is very striking. The intense and severe lateral bending action comes on the track as a whole as the locomotive passes around the curve, tending to push the ties and ballast first to one side and then to another and to throw the curve out of line.

It may be of interest to estimate this lateral bending moment in terms of the vertical bending moment of the rail under the same wheel. The ratio of the lateral bending moment in the inner rail under the fourth driver of three Santa Fe type locomotives (two of them belonging to the Atchison, Topeka & Santa Fe Railway and one to the Southern Pacific Company) to the vertical bending moments developed at the same time averages 0.16 at the lowest speed on the 10 deg. curves. It should be recalled too that the vertical bending stress under this driver was far greater than the normal and that the pressure of the driver on the rail must have been nearly twice the normal load. The ratio of the lateral bending moment under the same



COMBINED LATERAL BENDING MOMENTS IN THE TWO RAILS OF CURVED TRACK, HEAVY SANTA FE TYPE

wheels to the vertical bending moment found generally on straight track averaged 0.04, although values as great as 0.14 were found. As the section modulus of the rail about a vertical axis is only about one-fifth that about a horizontal axis, the lateral bending stresses in the rail are relatively great in comparison with the lateral bending moments. It will be seen that the lateral bending effect on the 10 deg. curve under the fourth driver of this locomotive (taking the average value found) is at least four times the average value found on straight track and at least twice the highest value that may be expected.

Effect of Speed and Counterbalance on Curves

The effect of the counterbalance on the stresses in rail on curved track is much more variable than that found on straight track. One interesting result of the study of the data is that, under a number of the wheels, the stresses at the outside edge of the rail showed marked effect of counterbalance, whereas those at the inside edge show almost no counterbalance effect.

The effect of speed on the division of the load of the locomotive between the two rails of the curve is quite another matter. In most cases, the total load on the outer rail transmitted by all the wheels of one side of the locomotive bears the numerical relation to the total load on the inner rail that would be given by the analytical calculation of the effect of transverse inclination of track and centrifugal force at the given speed. This means that at slow speeds the load on the inner rail is considerably greater than the normal load, the vertical bending stresses in the inner rail with the Mikado type locomotive running at a speed of 5 miles per hour being found to be as much as 37 per cent greater with the super-elevation of 8.5 in. on the 6 deg. curve of the Delaware, Lackawanna & Western Railroad than on straight track. At and near the speed of super-elevation, in most of the tests on curved track, the vertical bending stresses in the two rails do not differ much from each other. It may be noted that analysis shows that the speed may be increased considerably beyond the speed of super-elevation before the load on the outer rail would become equal to that imposed on the inner rail at low speeds. Although the ratio varies with the degree of curve and the super-elevation used, it may be said that for the track used in the tests the speed may be increased 30 to 40 per cent beyond that of super-elevation before the load of the outer rail may be expected to equal that found on the inner rail at low speeds. The foregoing discussion refers to the sum of the loads under all the wheels; the distribution of load among the several drivers may be quite unequal, the vertical bending stresses in the rail under one driver of one type of locomotive being as much as double what might be expected in the case of the 10 deg. curve and 50 per cent more on the 6 deg. curve.

The lateral bending stresses developed in the rails also vary with the speed. The lateral bending stresses in the inner rails are very great at the slow speeds, especially at the driver in front of the rear driver, and sometimes the one in front of this, in the case of the locomotives having eight and ten drivers. For medium speeds, say, up to two-thirds of the speed of super-elevation, the lateral bending stress under the rear intermediate driver continues to be of considerable magnitude. For the higher speeds, the lateral bending stresses under these wheels decrease markedly and at the speed of super-elevation the highest lateral bending stress in the inner rail may not differ greatly from the highest stress found in the outer rail. The greatest lateral bending stress in the outer rail under a driver is found at the outer front driver in those locomotives in which the wheel of the leading truck does not assume the principal part in changing the direction of the locomotive. With an increase in speed, this lateral bending stress increases. As the stresses in the outer rail under the wheels of the front truck do not increase with an increase in speed, it is evident that the greater effort to change the direction of the locomotive at the higher speeds is taken by the flange of this first outer driver.

Type of Locomotive

On straight track the stresses developed in the rail are controlled by such matters as the wheel loads and the wheel spacing. Lateral bending stresses are developed by reason of the coning of the wheels, the variations in the movement of the locomotive, and by irregularities in track conditions. Variations in the design of locomotives, such as the length of wheelbase, the number of drivers, the use of two-wheel or four-wheel trucks, may be made without bringing unduly high stresses in the rail, provided proper care is used in making the design. On curved track, other considerations will be found to enter into the development of stresses in the track. The change of direction of the locomotive in going around a curve is effected by pressure between the flanges of the outer wheels of the front truck and the outer rail and frequently, also, by the outer first driver, resulting in a lateral bending of the outer rail. An unexpected effect is the greatly increased load transmitted to the inner rail by one or more of the drivers at low and medium speeds and a corresponding decrease in the load on the opposite driver, the conditions producing excessive vertical bending stresses in the inner rail. The lateral spreading action on the inner rail develops marked lateral bending stresses in that rail. In all these matters, the characteristics of the type of locomotive will be found to influence the action of the locomotive and the nature and amount of the stresses developed in the rail under the various wheels.

In the matter of changing the direction of the locomotive, it seems evident from the tests that the four-wheel truck of the Pacific and Mountain types presents advantages over the two-wheel truck of the Santa Fe and Mikado types. With the four-wheel leading truck used, the loads on the wheels are such as to give moderate vertical bending stresses. The lateral bending stresses in the outer rail under the outer wheels of the four-wheel truck on curves from 4 deg. to 10 deg. may be termed moderate. With the locomotives having the four-wheel trucks, there is little or no outward bending stress developed in the outer rail under the first driver, this driver participating in the turning action only at the highest speeds. With the two-wheel front truck, the lateral bending stress in the outer rail under the first driver may become very great.

What New Railway Equipment Costs

A decision of the Interstate Commerce Commission of February 2 granting authority to the Baltimore & Ohio Railroad to issue equipment trust certificates for the purchase of new equipment shows what the railroads have to pay for new rolling stock.

The total order of the Baltimore & Ohio Railroad amounts to $18,704,625, and calls for 50 Mikado locomotives at a cost of $54,869 apiece. Two electric locomotives cost $69,575 apiece.

One thousand 70-ton steel coke cars average $2,309 each and 1,000 55-ton steel hopper cars cost $1,784 apiece.

Another three thousand 55-ton steel hopper cars range in price from $1,650 to $1,774 apiece.

One thousand 70-ton gondola cars cost $2,300 each, and 1,000 steel underframe box cars with a 40-ton capacity cost $2,068 each. One thousand 40-ton steel box cars cost $2,066 each.

A Thought for the Day

"The cost within the last five years of unnecessary commissions and regulatory concerns, commissions to control and regulate railroads, to regulate every butcher shop and every slaughter house, to regulate the production of fuel and its sale, to regulate the practice of medicine, to supervise the birth of babies and the burial of the dead—everything which the heart can desire or fancy can conceive, from the setting of a hen to the running of a railway—all this has cost the difference between $232,000,000 in 1916 . . . and $1,115,000,000 in 1922. The cost of the Government's doing things it has no business to do, employing people who ought to be *paying taxes* instead of *eating taxes,* regulating matters which should be left to the States and the citizens thereof, is now more than the cost of operating this Government, everything included . . . from the inauguration of George Washington to the Civil War."—Senator Stanley.

Origin and Development of the Pennsylvania R. R. Testing Laboratory

Its Establishment Under the Direction of Theodore N. Ely

By GEO. L. FOWLER

It is safe to say that at the time of the appointment of Mr. Theodore N. Ely as superintendent of motive power of the Pennsylvania Railroad in 1874, there was not a specification for material worthy the name in force on a single railroad of the United States. Supplies were bought on the reputation of the manufacturer, a reed that often proved to be but a frail support, and useless as a guarantee that what was wanted would or could be procured. There was no railroad in the country that had even the faintest semblance of a testing laboratory, and there were few, if any, railway officers who appreciated the necessity for one. Inspection, even, was of the most perfunctory character, and it is doubtful if there were many who would have believed in the efficiency or value of such work even if it had been suggested. That Mr. Ely foresaw the future of what he was to inaugurate is not at all probable. He was confronted by a necessity, a real need, that of obtaining certain supplies that would meet the requirements of the service. He had found it impossible to obtain these supplies in the old and usual manner. He felt convinced that he and his road were being imposed upon by unscrupulous manufacturers and he cast about for a means of meeting the emergency. His method was to find out two things; one as to what he was receiving, and the other as to what he needed in order to obtain the best results. The latter has been the basis for the Pennsylvania specifications for material that have made a reputation for themselves all over the civilized world. To gain this information his resort was to analysis, chemical and physical, of the things offered and used.

He, therefore, took the matter up with the higher officials of the road, showed the need of information regarding the character of the supplies, explained his proposed method of obtaining that information and the uses to which he intended to put it, and finally, though few believed in the practicability of the scheme, the confidence in him, personally, was such that he did obtain an appropriation of ninety dollars a month for a chemist.

If one were to scan the roster of the men who have occupied responsible positions at Altoona during Mr. Ely's administration such a one will be struck by the high character and ability of those with whom Mr. Ely surrounded himself, and it is due to such a selection that much of the success of his work there was due. But of all the men that he gathered about him he never made a wiser choice than he did in his selection of Charles B. Dudley as the first chemist for the road. A man who was afterwards to make a world-wide reputation for himself and his laboratory as the chemist for the Pennsylvania Railroad.

It was in 1875 that he succeeded in obtaining the meagre appropriation for the work. Meagre at first because of the novelty of the undertaking and uncertainty as to its value, but, as soon as it had demonstrated its worth, its support was generous in the extreme, and the testing department has had nothing of which to complain.

With his usual care, Mr. Ely began his search for the man who was to be his main support in his fight for better and purer goods than he had been able to obtain through the ordinary channels.

The employment of a chemist was the first great step in advance, though there was, at the time the embryo of a testing laboratory in the form of a small Fairbank's testing machine, of 50,000 lbs. capacity.

The immediate reason for starting a chemical laboratory, instead of further developing the physical, was that certain things happened in connection with the furnishing of supplies to the company that seemed to call for the critical scrutiny of articles purchased for consumption and entering into construction, more particularly such articles as oils, paints, varnishes, etc., that were purchased in large quantities. The material received was irregular in quality and, in many cases, the price seemed to be entirely unwarranted by the quality of the goods. This led Mr. Ely to look for someone, some expert chemist who could examine the supplies with a view to not only checking the receipts but preparing specifications for future use.

The matter being thus presented, the consent of the general manager and the Board was obtained to the employment of a chemist.

In the selection of such a man, someone to fill this position, it was, of course, all important that the man who was chosen should be strictly honest, scientifically impartial and one who could, under the necessities of the case assist by the suggestion of methods and procedure.

It was upon the suggestion of Dr. Coleman Sellers of Philadelphia that Mr. Ely had an interview with Dr. Charles B. Dudley, who was then teaching school at Poughkeepsie, New York. The result of the interview, as all the world knows, was that Dr. Dudley was engaged as the first chemist regularly employed by the Pennsylvania Railroad and probably as the first chemist employed by any railroad in the United States. This was in 1875. A small laboratory was partitioned off in the shops and he began his work.

Coincident with this, the department of physical tests was amplified and John W. Cloud, who was then in Mr. Ely's business office, was appointed engineer of tests, so that the collaboration of these two men in their work formed the test department, which ultimately grew to large proportions and into a constantly increasing importance.

Under the circumstances of its formation there were naturally many doubts, in the beginning, on the part of the officers of the road and others, as to whether or no such a department would be too expensive to maintain, when compared with the importance of its work. But the almost immediate success of some particular investigations made by Dr. Dudley settled the question for all time, not only as to the value of the work but as to its necessity.

During the thirty-five years that Dr. Dudley was at the head of the chemical laboratory, the department may be said to have conducted investigations into almost every branch of human knowledge. It is, of course, impossible and undesirable to review or even catalogue all of these activities in detail, but it will be well to consider a few of them for the purpose of showing the general character of the work and the way in which it was done.

One startling bit of work, that was done in the early days, was the development of a test for the determination of the adulteration in lard oil. The preliminary work had been done, when Mr. Ely received a letter from Admiral Brown, asking about the tests which had come to his attention, and inquiring whether the Altoona laboratory could help him out in the matter of signal oils, especially as to the oils that were used in the lighthouses. along the coast. He said that many of the lights were growing dim and some of them were going out, and that the government was having much trouble and much danger. Upon a receipt of a sample of the oil used, from Admiral Brown representing a purchase of 13,000 gallons, it was found that eighty per cent of the oil was cotton seed oil. It had been bought for pure lard oil. Cotton seed oil being a vegetable oil, the wicks gummed over and would not burn. Then there was trouble. At the time the Altoona authorities did not dare tell of their method of detecting the adulterations of oil, lest the manufacturers should concoct some scheme for circumventing them. The method was, however, very simple. A little sulphuric acid was added to a test tube containing the oil, when it would suddenly become hot, and the increase of temperature due to the addition of the sulphuric acid was in an almost exact proportion to the amount of vegetable oil that had been added to the animal oil. And that was all there was of it.

The manufacturers denied that they were adulterating the lard oil, and insisted that there was no means of detecting the cotton seed oil that did not exist. So emphatic were their denials and challenges that the purchasing agent and all his friends were skeptical. So Mr. Ely invited them all to come to Altoona to be convinced. He gave them some pure cotton seed oil and some pure lard oil that he had had expressed from the hog itself in the laboratory. They were sent into a room in the laboratory and told to mix the two oils in any proportion that they chose and to number the bottles for identification. This was done and the bottles turned over to Dr. Dudley. Before they left they were told as to the quantity of cotton seed oil that had been added in each case, and whether any had been added or not. In his results Dr. Dudley came within one or two per cent in each case. The skeptics were convinced, and it is difficult to appreciate the widespread influence of such a demonstration. It showed that the laboratory was issuing its reports on the basis of positive knowledge, and with that reputation a man knew that he must be equally sure before entering upon a controversy. Aside from its moral effect the value of this particular investigation to the government and to the shipping world was incalculable when it is considered as to what it really meant to adulterate the oil that is to be used in lighthouses.

Another exceedingly important investigation of those early days was one regarding the relationship between the chemical and physical properties of steel rails. The investigation was one of great importance as it showed the relations of phosphorus to carbon, silicon and manganese in the composition of metal.

With everybody skeptical it was exceedingly fortunate that a man like Dr. Dudley was in charge. He was a practical Yankee, and as such he appealed very strongly to Mr. Ely, who gladly paid him the whole of the ninety dollars granted by the appropriation. And Dr. Dudley was just the man for the place. He took hold of a few practical things that he could demonstrate like the cotton seed adulteration.

Another case was an inquiry that came in as to the cause of the rapid eating away of the engine valves. It was before the day of mineral cylinder oils, and the rapid corrosion was not because the valves were not well lubricated.

Tallow was used in those days and this inquiry was one of the first things that Dr. Dudley got hold of. He showed that the trouble lay in the fact that the tallow was rancid when it was used, and that, if it were fresh, there would be little or no corrosion, hence the necessity for obtaining and using freshly tried tallow. The laboratory was fast establishing itself and its reputation, and Mr. Ely was supported in any increase that he asked for it.

Meanwhile the work of the physical laboratory was progressing with almost equal rapidity.

At that time, between 1873 and 1878, the country was flooded with a great mass of helical springs made from all sorts and shapes of bars and wound over a variety of mandrels. Each of these shapes was patented, and for it its patentee claimed some good quality, which it was very desirable that a spring should possess. But the royalties demanded for these special forms were a burden upon the railways, and no information was in their possession to guide them in the purchase and selection of springs best suited to their purpose.

As an example of what was done, a certain wool packed spring may be cited. This spring consisted of a number of small spiral springs set in a case having a cover to it, and these spirals were packed with wool. It was an example of the purest kind of chicanery, because the wool packed into the spiral would not have any perceptible effect on a spring with a big load. So a "spring machine" was designed and the spring was put under a lever and the proper load applied to it in such a way that it could be moved up and down by hand and the quality of the motion ascertained. As compared with the ordinary helical spring as now used that of the "wool packed" spiral was like a block of wood.

The problem was, therefore, set before the physical laboratory to ascertain the best type of spring and the best quality of steel from which to make it. A steel was finally selected and sent to the Watertown, Mass., arsenal for the determination of its modulus. It was then rolled into various shapes and springs were made and tested, with the result that the plain round bar proved itself far superior to any of the patented shapes, and Professor Ruleaux's formula for the calculation of the resilience and strength of helical springs was established by practical test. The round bar was, thereupon, adopted as the standard of the road, the patented shapes were discredited and in a remarkably short space of time they disappeared entirely from use to the great benefit of safety and cost on every railway in the country.

These chance examples will serve to show the character and quality of the work that was done in the early days in the two laboratories, physical and chemical, at Altoona, and the importance of the work not only to the Pennsylvania Railroad but to every road in the country, if not in the world.

But as already stated, one of the principal objects which Mr. Ely had in the establishment of the laboratories was the development of specifications under which supplies could be purchased, manufactured and inspected. The principle upon which the specifications were developed was first to learn exactly what article was needed, so that the specifications might be drawn in a way to insure that the article would be furnished. While this, on the face of it, would seem to be a simple proposition, it was, after all, quite difficult to accomplish, for many things had to be taken into consideration and studied, more particularly the facilities existing and that could be economically created for furnishing the article, which made necessary a careful and critical study of all sorts of supplies from steel to plush. This done, it has been possible to stiffen the specifications and make them more and more rigid as improvements have been made in the manufacturing of the article covered.

Then, too, it was very important not to specify an article the cost of which was greater than the necessities of its use and purpose warranted, and data regarding this feature of the situation were procurable only from the manufacturers. For example, in the various uses of steel and iron, there are many places which are subjected only to wear and where strength enters as a minor consideration, and where a low priced quality would serve as good a purpose as a more refined and more expensive quality. So it came about that, in many instances, the best things that could be obtained were not specified. To do this would have been very extravagant management, whereas the best thing for the purpose would have been and was economical. Before this system was established it was customary to buy material for protecting wooden surfaces of as high a quality as that used for boiler plate, and it cost as much per pound. And so many things were developed by the testing department. It was really a department of economics.

To take the matter up in detail, the method of working out and developing a specification was, first of all, to ascertain what was wanted. Frequently the inquiry was started by the failure of something in service to give satisfactory results obtained from materials purchased from different manufacturers, and the desire to standardize the practice over the whole road. Having determined the approximate quality desired, attention is turned to the process of manufacture so that requirements may not be imposed that will be burdensome or impossible to fulfill. This done, a tentative specification is drawn and submitted for criticism to those interested in the purchase, use or manufacture of the article. Then, when these criticisms have been received, they are carefully reviewed and digested and the full specification is drawn, which is sent out for use in the purchase inspection and acceptance of material.

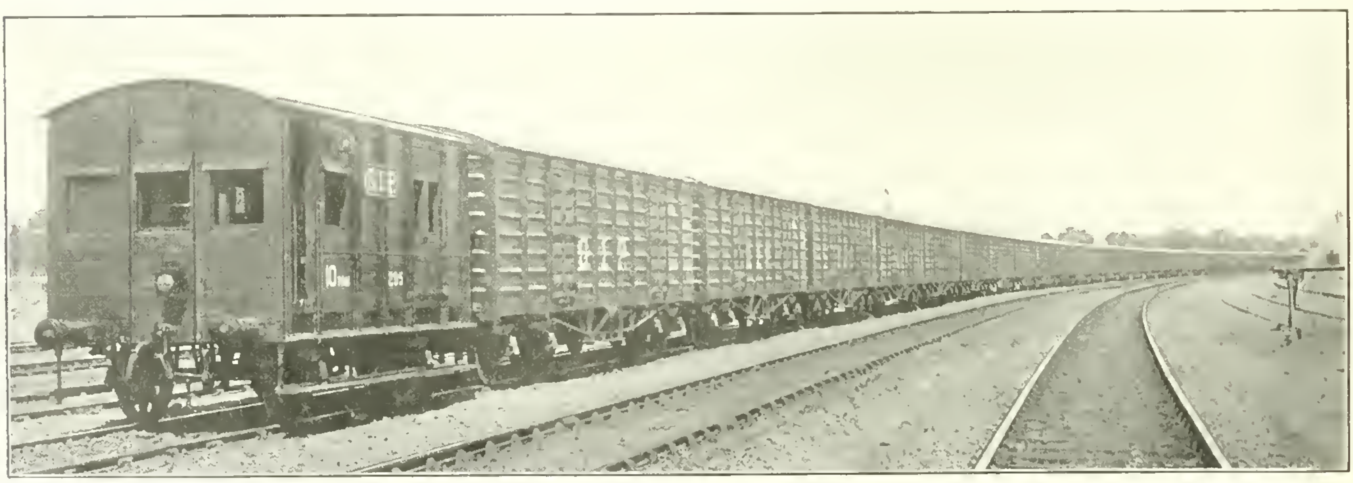
The specifications that have thus been prepared now cover a very wide variety of materials, and so carefully has the work been done, and so thorough have been all of the precautions to insure that they shall be fair to both the buyer and the seller that they have frequently been adopted without a question by others who are without the equipment to prepare such specifications for themselves, and because of their reliability, they have become a national asset.

It is well within bounds to say that there is probably no department of the Pennsylvania Railroad that has made so world-wide a reputation for itself, and whose influence is so wide as this testing department established by Mr. Ely in 1875, with a single chemist working in a small room partitioned off in a corner of the Altoona machine shop.

Steel Freight Cars for Great Indian Peninsula Railway

By Our India Correspondent

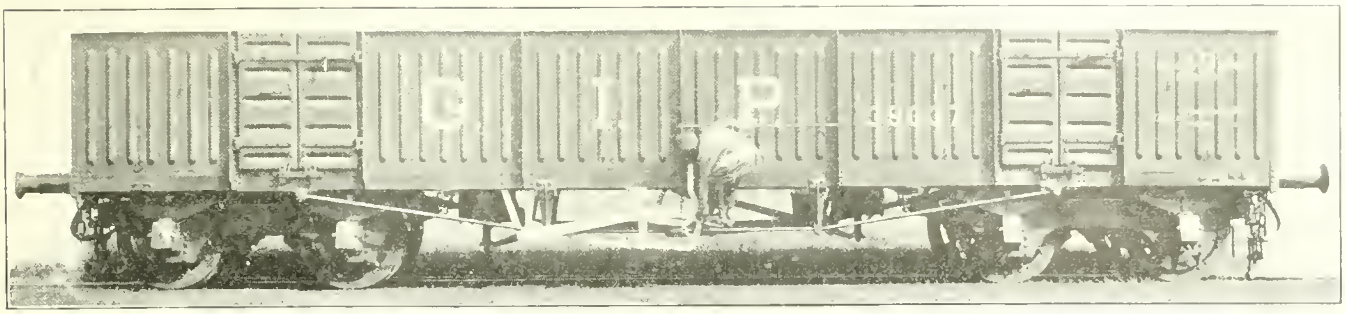
Although the accepted practice in India is the four-wheeled wagon after the type of the British, but of larger capacity, there are now quite a number of bogie vehicles running, and the Great Indian Peninsula Railway, which carries large quantities of cotton, seeds, etc., have been the pioneer railway to put into general use larger and more capacious vehicles.



2000 TON TRAIN ON THE GREAT INDIAN PENINSULA RAILWAY

The train shown in the illustration is made up of steel bogie cars, each with a carrying capacity of 40 to 45 tons (2,240 lbs.). The bodies of these cars are of steel with pressed corrugations to give them stiffness. They are well framed together on standard "Ts," etc., the whole mounted on underframes built up of channels 8 x 3 x 5-1/16 in., with longitudinals and headstocks 10 x 3½ x ⅝ in. There are two 4-wheeled trucks having wheels 43 in. diameter, and axles with journals 10 x 5 in. The axle boxes, brakegear, etc., are to I. R. C. A. standards. The doors are of folded type and they (like the sides) are corrugated for stiffness. The thickness of the plate is 3/16 in. Chainless fastenings have now been introduced to counteract the tendency of theft of chains and loose fittings experienced in India. The cars are fitted with both hand and power brakes. The hand arrangement is of the side lever type known as "Little Giant" compound lever arrangement. The arrangement is such that with a man of ordinary weight standing on the side lever can exert a pressure of 8 tons on the brake blocks of one truck; the photograph shows how the Indian shunters operate this arrangement. The power brake is of the continuous automatic vacuum type with the standard brake equipment for the Indian Railways.

The third illustration shows an open car of similar construction built for the transport of manganese ore, coal, grain, etc. The load limit is 40 to 45 tons, depending on track.



OPEN 40-TON WAGON, SHOWING THE HAND BRAKE BEING OPERATED BY NATIVE SHUNTER

Hand Brakes on the Pennsylvania

The Pennsylvania R. R. has instituted a suit against the several members of the Interstate Commerce Commission asking for an order restraining them from the enforcement of the law regarding the use of hand brakes on certain grades.

The law requires that trains shall be so equipped with power brakes that the engineer can control the speed without requiring the brakeman to use the common hand brake for that purpose, and imposes a penalty of $100.00 for each violation.

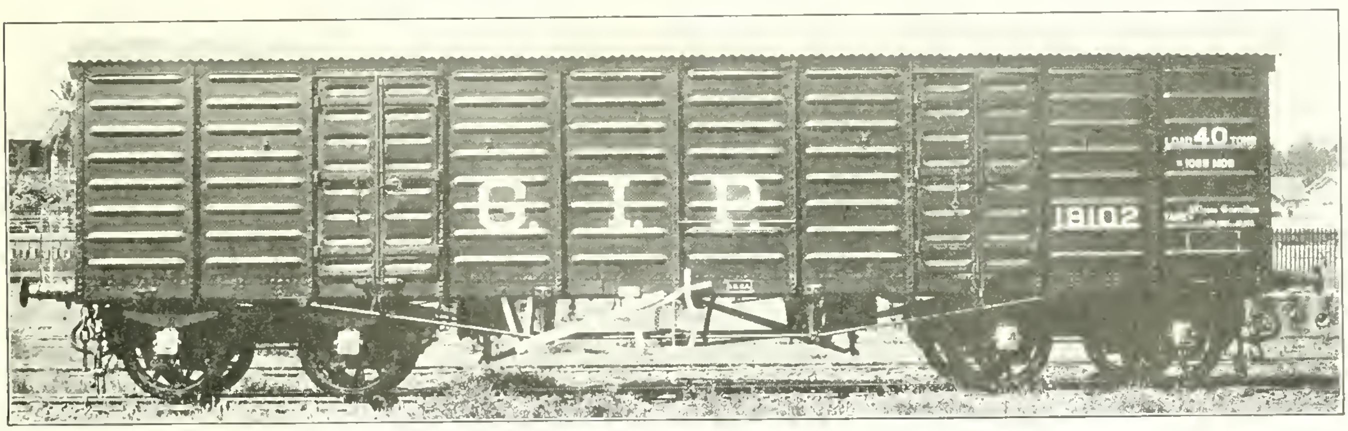
In its petition the railroad states that:

"In the operation of its trains, complainant is required to move the same over certain steep descending grades of approximately 100 feet per mile.

"That the cars in the trains operated by complainant over these grades are equipped with power or train brakes, to the extent required by the Safety Appliance Acts, and these brakes are used for the purpose of controlling the speed of the trains while descending these grades, but in order to add to the effectiveness of the brakes, and consequently to add to the safety of the trains while descending these grades, complainant requires the use of some of the hand brakes on the trains, for if the tendency of the trains to increase their momentum on these descending grades were not reduced in some other way than by the application of the air brake, the engineers could not regulate or control their speed while on the grade as effectively and as promptly as they are enabled to do, if the increase in momentum due to the descending grade had been checked and reduced in some other way."

The petition then goes on to state that in order to so control the action of the cars as to keep the slack beween the cars from running in and out, which results in shock, a certain number of hand brakes are applied. The hand brakes are applied and released while the trains are in motion and even if they were not so used the brakemen would have to be so stationed on the trains as to be prepared to apply the hand brakes, should any emergency arise that rendered their use necessary. The additional factor of safety thus produced is claimed to be important and desirable.

It is for these and other related reasons that the complainant railroad asks that the "Safety Appliance Acts, may be held and declared to be inapplicable to the use of the hand brakes on steep grades on all trains which are equipped with power brakes, to the full extent required by those acts."



40-TON COVERED WAGON ON THE GREAT INDIAN PENINSULA RAILWAY

German Diesel Locomotives for Russia

The chief of the Russian railway commission in Berlin is reported to have contracted with the Deutsche Werke for the construction of a number of Diesel-engined locomotives. The first two, one with electric and the other with hydraulic transmission, must be delivered during the summer of 1923.

These locomotives will cost approximately twice as much as steam locomotives, but they have the advantage, among others, of being capable of operation without water, a distinct improvement in a country where water is scarce. This feature will permit the extension of railways into sections of Russia where now they are nonexistent.

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The Heavy Rail

The heavy steel rail as it is used to day is the result of many years of evolution and development. It was about 1887 that Sandberg designed a 100-lb. rail, and so far away did it seem at the time that it was hardly taken seriously. In fact it was made the subject of a friendly joke on the part of John Fritz, of the Bethlehem Steel Co. Mr. Fritz came back at Sandberg with the design of a 1,000-lb. rail. The end of the section of the rail in the drawing was made to represent a fractured piece of steel, and the shading of the fracture of the head of the rail was such that a portrait of Sandberg appeared. This drawing was sent to Sandberg by Mr. Fritz with his compliments and the suggestion that he go the limit at once and not spend time on the designing of a Lilliputian rail of 100 lbs. to the yard.

But the 100-lb. rail was crowding very closely at the time and appeared in service in this country within four or five years of the date of Sandberg's design.

In 1884 there were 80-lb. rails in service. These had heads 2-11/16 in. wide and were 5 in. high. In the early rails the height and width of flange were about the same, but since 1884 it has been common practice to make the flange width less than the height. The 100-lb. rail designed and put into service by Dr. P. H. Dudley in 1892 had a height of 6 in., a flange width of 5½ in. and a width of head of 3 in. In all of his work from the 80-lb. section of 1892 to the 120-lb. section of 1916 Dr. Dudley has held the radius of the top of the head at 14 in.

In view of the small area of contact existing between the wheel and the head of the rail, it would appear that the principal benefit to be derived from the heavy rail would be from its strength as a girder, because the cold rolling effect and, therefore, the wear of the rail ought to be the same. This would be modified to a certain extent by the width of the head. As, for example, where there is a width of 3 in. in the head of rail as in the 100-lb. and heavier rails, compared with the 2-21/32 in. width of the 80 and 90-lb. rails.

But it appears that the greater body of metal in the heads of the heavier rails protects the metal in the surface and prevents a flow or wear which would occur with a narrower head.

This is an important feature in that it has been Dr. Dudley's experience that the head of a 6-in. 100-lb. rail will outwear three heads of 5⅛-in. 80-lb. rail in switching service. Again, he has found that on the Pennsylvania division of the New York Central, under a mineral load traffic of 60,000,000 tons a year, the 6-in. 100-lb. rail will outwear 2.7 heads of the 5⅛-in. 80-lb. rail. The same ratio applies in a general way to the 105-lb. rail

It thus appears that the heavier rail justifies itself in wear, aside from its stiffening effect as a girder of greater depth. In fact the ratio of wear, according to the above statements, increases much more rapidly than the weight or stiffness. For example, the increase of weight between 80 and 100 lbs. is 25 per cent. The moment of inertia rises from 28.5 to 48.5, or about 70 per cent, which may be considered to be the increase in stiffness, while the wear rises from 1 to 2.7, or 170 per cent. So it appears that Sandberg was simply a little in advance of his time, and that the heavy rail is justifying itself in both wear and strength.

Production and Conservation of Steam

The railroad problem has for some time, and is now, of such character that the most rigid economy in all departments is necessary and this is particularly true as to the mechanical department, for it should be borne in mind that every dollar earned by a railway company for transportation is earned by a locomotive and approximately 22 per cent of operating expense is for maintenance of equipment. To more clearly point the necessity for attaining the highest possible degree of economy in the mechanical department especially in locomotive design and operation, the amount involved should be stated.

The average earnings per engine in service may safely be placed at more than $100,000 per year, and the average cost of fuel per engine in service more than $12,000 per year, so that even a slight reduction in fuel used or increase in engine capacity means a substantial increase in net income.

There has been in recent years many improvements both in the design of new locomotives, and devices for application to existing engines, that add much to their efficiency and economy in service, many of these devices have to do with the conservation of steam, while some affect only production, and although a net dollar saved one way is of the same value as 100 cents saved in any other way, there are nevertheless certain directions in which a given expenditure will yield greater returns than others, and this is particularly true with respect to increasing the capacity, and thereby the *sustained efficiency* of a locomotive without building a new boiler, for in the last analysis, engine efficiency and boiler capacity are synonymous terms

In the best designed engines of today there is quite a fuel loss between the *fire door* and *draw bar*, while there are many hundreds, if not quite a few thousand engines that are either over cylindered, of the fire box is of a design that lends itself to the application of increased steam producing features from the same amount of fuel and in either case a continuous double saving can be effected on a single expenditure, which in comparison to the cost of a new boiler is a mere bagatelle.

Any device, method, or means for enlarging the most effective heating surface whereby the water circulation is increased, thus stimulating evaporation of water, and producing more steam with a given amount of coal, will show much economy in fuel on modern engines with ample boiler capacity, while for those lacking in sustained efficiency or productivity, this is a commonsense business-like method of remedying this defect.

In the January issue of this paper there appeared a graphic analysis of locomotive boiler proportions by C. A. Seely, Chief Engineer of the Locomotive Fire Box Company, who manufacture the Nicholson Thermic Syphon, in which specific cases are shown of engines successfully handling increased tonnage following the application of this device, thus supporting by actual facts the claim of increased capacity and sustained efficiency resulting from its use.

That the favorable results following the application of this device has attracted the attention of motive power officers and others interested in this particular branch of railway economics is evidenced by the fact that there are over 600 in use, and the following orders in the last few months:

Name of Railway	Type Locomotive	Number of Installations
Rock Island	Mikados	30
Rock Island	Mountain	10
Erie	Mikados	40
Erie	Pacific	20
Ill. Central	Mikados	75
Ill. Central	Old Engines	10
Central Ga.	Mikados	10
N. C. & St. L.	Mikados	12
Santa Fe	Mountain	2
Santa Fe	Pacific	2
Santa Fe	Santa Fe	2
Balto. & Ohio	Consolidation	25
T. & N. O.	10 Wheelers	6
L. S. & I.	10 Wheelers	3
Total		247

A most important feature of this proposition is that it is essentially a means of increased "steam production and engine capacity," as distinguished from devices for conserving or more economically using steam, and the endorsement of leading railway officers, as evidenced by the orders and installations, are indicative of its more extended use, particularly so in view of the fact that there are so many hundreds of locomotives now in use that if subjected to this line of treatment will show such wonderfully inviting returns on the investment.

Results of Railroad Operations in 1922

Dr. M. O. Lorenz, Director of the Bureau of Statistics of the Interstate Commerce Commission, has prepared, and made public, a survey of the railroad year 1922, a part of which is as follows:

During the past three years, 1920, 1921 and 1922, the financial condition of the steam roads in the United States has materially improved. In 1920 the revenues scarcely covered expenses and taxes. In 1921, in spite of a 25 per cent drop in business done, as compared with that of 1920, the net railway operating income, which is the sum remaining out of revenues after operating expenses, taxes and certain rentals have been met and which is available for interest, rents for lease of road, dividends and surplus, rose to $616,000,000. This result was accomplished by a drastic cut in expenses, the number of persons on the payroll being reduced in 1921 about 18 per cent below the employment in 1920. In 1922 the net railway operating income, in spite of a reduction of 10 per cent in freight rates, effective July 1, 1922, was increased $777,000,000. The revival of busines more than overcame the handicaps of the strikes of the miners and shopmen in 1922.

When it is considered that the interest, rents and similar deductions, commonly known as fixed charges, of these roads are around $669,000,000, it will be seen that, regardles of any disputes about valuations, the roads did not earn enough in 1922, even if account be taken of the non-operating income, which before Federal control averaged about $200,000,000 for the Class I operating steam roads. (The corresponding non-operating figure for recent years is not comparable on account of Federal control and guaranty period accounting complications.) A substantial margin above fixed charges is obviously necessary in any business.

Better Outlook for 1923

The marked increase in traffic in the closing months of 1922 and the probability that, as the effects of the two strikes recede, the roads will have their operating expenses under still better control, make it probable that the net railway operating income will in 1923 approach more nearly to what the Commission has indicated to be a fair return, namely, a return of 5¾ per cent on a valuation of $18,900,000,000 as of December 31, 1919, plus subsequent net additions to property. If this valuation is tentatively assumed to be 19.4 billions for the mileage used by Class I roads, the return of 5¾ per cent would be $1,116,000,000 annually. On the whole, the present railroad situation, from the standpoint of railroad finance, clearly does not, on the one hand, warrant pessimism, nor, on the other hand, at present, any radical reduction in total charges to the public. From the standpoint of the public, which is interested in adequacy of the service and in the fairness of the charges, two facts stand out prominently: (1) An enormous traffic has recently been handled in spite of the strike handicaps, and (2) the average revenue per ton per mile is pretty well in line with the general level of wholesale prices and there is no reason to believe that the general level of rates is retarding the business revival, whatever may be the adjustments which investigation may show to be desirable in the relationships between commodities or communities.

The results of operation for the calendar years 1922, 1921 and 1920 are shown in the following table:

Class I Steam Roads

Account.	1922	1921	1920
	(millions of dollars)		
Freight revenue	4,007	3,928	4,324
Passenger revenue	1,076	1,154	1,287
Railway operating revenues	5,617	5,573	6,225
Maintenance expenses	1,995	2,021	2,624
Transportation expenses	2,175	2,288	2,902
All operating expenses	4,456	4,604	5,830
Taxes	305	280	281
Net railway operating income (1)	777	616	58
Ratio of operating expenses to operating revenues—per cent	79.32	82.61	93.65

(1) Represents the results of deducting from railway operating revenues the following items: Railway operating expenses, railway tax accruals, uncollectible railway revenues and net equipment and joint facility rents.

Observations On Electric Railway Practice

A Comparison of Practices and Developments in the United States and Abroad

By W. B. POTTER

Engineer, Railway Engineering Dept., General Electric Company

The development of rail transportation since the day of stage coaches and horse-drawn tram cars has been a process of evolution in which some reminders of the past are still noticeable.

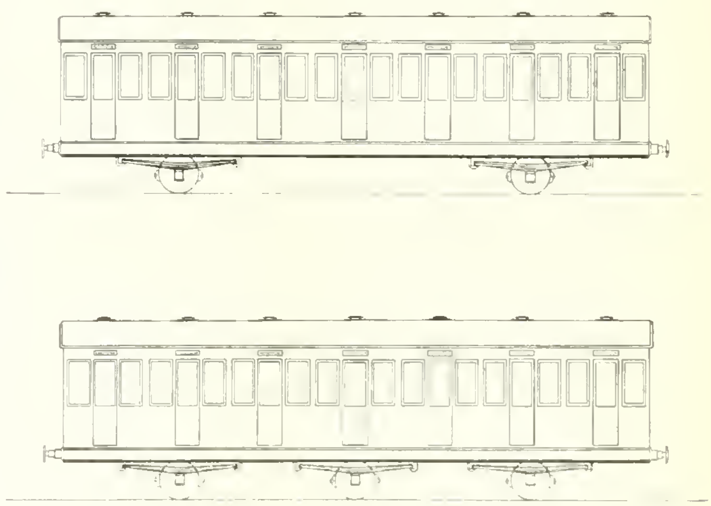
Before the days of steam the track gauge used for the tram cars of the British coal mines was presumably the origin of the odd dimensions of 4 ft. 8½ in., which has become so generally accepted as the standard track gauge of the railroads of today. In Great Britain freight cars are still called "waggons," and many of the older passenger vehicles there and on the continent are a sort of multiple unit stage coach in arrangement and interior fittings. These passenger coaches are much as if several coach bodies were mounted on a flat car, and to carry out the illusion, the exteriors of the separate compartments are sometimes so paneled as to resemble the outlines of a coach. The doors, windows and the interior are as nearly like the old stage as one could imagine, not omitting the looped strap-arm rest for those sitting at the ends of the seats.

The single truck of the old horse-car was not suitable for the higher speeds and longer car bodies soon called for in electric service. The bogie or double truck motor car so generally used today was a natural adaptation from steam railway practice, and the simplicity of this design was early appreciated as advantageous for electric locomotives. One of the first electric locomotives used in regular service in this country was an electrically equipped bogie truck railway express car. The motor car practice of mounting geared motors directly on the axle has been quite generally applied and proven very satisfactory for electric locomotives. In continental Europe the development of the electric locomotive seems largely to have been carried out with the idea of substituting the electric motor for the steam locomotive cylinder and retaining the feature of connecting rod drive.

While there is a similarity in the character of traffic and the conditions under which it is carried on in the European countries, there is a great difference in these respects between Europe and this country. The influence of precedent, experience and individual opinion under these quite different conditions has naturally led to a different view point and to some differences in practice between this country and Europe. There is much to commend and little to criticize in the railway practice and equipment as it exists in the different countries. Each country has endeavored to provide transportation of a character most suitable for its particular requirements. Occasional visits to any country do not give opportunity of becoming well informed on this subject comprehensively, but even casual observations, as in this instance, may serve as an excuse for comment and comparison.

The weight of European freight trains and the maximum draw-bar pull allowed are about one-quarter of what they are in this country. The weight of their passenger trains is about one-half. The permissible weight on driving wheels is about two-thirds and the weight per axle of their cars is about one-half of our usual practice. The low draw-bar pull and car weight permit a relatively light mechanical design of rolling stock, and the requirements as to strength are further made easier by the method of car coupling.

The screw coupler, i. e., two clevises connected by a rod with a right and left hand thread used almost universally. Each draw-bar has a hook that is provided with a screw coupler, and in the process of coupling the clevis of one of the couplers is thrown over the hook of the other draw-bar, and the cars in effect are jack-screwed together by hand. There are two mushroom shaped buffers with faces about one foot in diameter; the right one having a rounded face and the left hand a flat face; these are located near the outer end corners of the car. The initial tension on these buffers is about 2,000 lb., and when fully compressed the pressure is approximately 20,000 lb. As might be expected, there is ordinarily no shock when coupling with this kind of a coupler as a slight compression of the buffers is all that is required.



OUTLINE OF CARS WITH TWO AND THREE AXLE TRUCKS USED ON EUROPEAN RAILWAYS

Admitting the advantages of the automatic type of coupler, the use of the screw coupler does permit a much lighter end framing on locomotives and cars. An inquiry as to European experience with automatic couplers brought forth the comment that the couplers were all right, but that the process of coupling wrecked the rolling stock. Allowing for various requirements, the weight of European electric locomotives is from two-thirds to three-quarters the weight of electric locomotives in this country having the same horsepower.

The speed of European trains on the average is rather higher than in this country. Many of the European cars have two or three axles which does not seem to be a wheel arrangement that would provide for smooth running. In many instances these cars have no truck framing, but depend upon the car springs to hold the axles in alignment. These springs are usually about six feet long and semi-elliptical in shape, al-

*From a paper presented to the American Institute of Electrical Engineers, New York, Feb. 14, 1923.

though so little curved as to be nearly flat. The springs bear directly on the journal boxes and are so resilient that the vertical shock from track joints is very well cushioned. The shorter wheel base two-axle car and many of the three-axle cars have a tendence towards transverse oscillation, which may be decidedly uncomfortable unless the cars are properly coupled together. The combination of the screw coupler and buffers has more influence in steadying the car and preventing oscillations than might be supposed. When the coupling is set up sufficiently to compress the buffers, the friction between them is sufficient to prevent any relative movement so that each car is steadied by the one to which it is coupled.

On a fast train made up of similar cars having bogie trucks, there was a noticeable difference in the riding qualities of those cars on which the couplers had been screwed up and certain others so loosely coupled that the buffers did not touch. It is the usual practice to screw up the coupler sufficiently to compress the buffers, but there are exceptions. A remembered instance was a trip on a two-axle car of about 14 ft. wheel base which was loosely coupled to the rear end of a passenger train. At a speed of about 55 miles the transverse oscillation, or "side slogger" as it has been called, was so bad as to cause some apprehension to the uninitiated. At the first stop the coupling was screwed up, which was all that was necessary to effectually check the "slogging." The frequency of these transverse oscillations appeared to be the natural period of the car body as established by the scheme and proportions of its flexible supporting structure. The track did not seem to induce any supplemental oscillation.

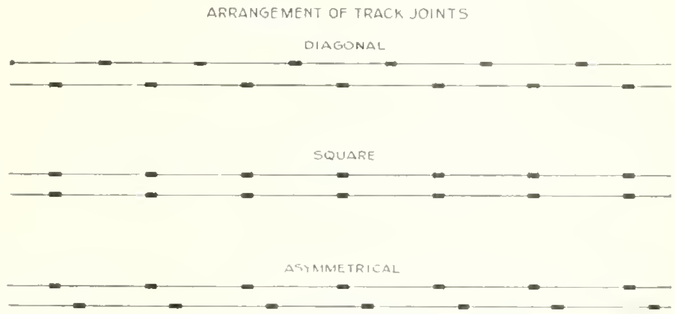
Track Construction

The method of locating track joints perhaps has more influence on the running quality of the rolling stock than is commonly appreciated. The European practice is to lay the track with square joints, i. e., with the joint of each rail directly opposite. The customary practice in this country is to lay the track with joints spaced diagonally and located midway between the opposite rail. The trial run of an electric locomotive over a track with square joints, which were in poor condition, afforded an exceptional opportunity to observe the reaction of a track with this arrangement of joints. This locomotive had bogie trucks and at about 60 miles an hour there was a very decided vertical vibration, but no tendency whatever toward enforced side oscillation. With diagonally laid joints, in as poor condition, it is questionable whether any locomotive or car could have been run at that speed without something giving way; particularly if the transverse oscillation, which is diagonal in direction relative to the track, had happened to synchronize with a diagonal location of the low joints. Only one railway in Europe was noted where the rails were laid with diagonal joints. The manager remarked that his electric motor cars were subject to so much oscillation that it was his intention to re-lay this track with square joints.

A comparison of the influence of square and diagonal joints on the running qualities of a motor car was recently observed in this country over a line having both kinds of joints. On the portion of track having square joints there was observed a slight steady oscillation of uniform character at the rate of about 150 per minute; on the portion of track with diagonal joints the same car did not oscillate with equal steadiness and at times had a noticeable swing toward one side or the other. As the car was running at about 60 miles per hour, the natural period of oscillation did not correspond with the location of the diagonal joints. Had the vibration synchronized with the joints, an enforced and increased oscillation might reasonably have been expected. This particular track was in good condition throughout.

There is no doubt that track laid with square joints is more difficult to keep up as the impact on the ballast is more severe when both wheels strike the joints simultaneously. With the less weight per axle customary in European practice, it is much easier to maintain their track than it would be with our heavier weights per axle.

The writer suggests that it might be possible to secure the advantage of diagonal joints in respect to track maintenance and the steadier running quality of



DIFFERENT PLANS FOR LOCATING TRACK JOINTS ON TRANSVERSE OSCILLATIONS OF A CAR

square joints by laying the track with joints asymmetrically spaced, that is, instead of overlapping a half rail length, to overlap between one-quarter and one-third, preferably a length of lap that would not be an even fraction of the rail length.

There was observed on the Great Northern Railway, England, an articulated arrangement of cars into groups, which is a departure from the conventional car with two bogie trucks. This articulation is acomplished by locating a truck miday between each of the several cars in the unit group, so that the number of trucks is only one in excess of the number of cars constituting the group. In the suburban service the trains were composed of two groups each of four cars, this requiring ten trucks for the eight cars. On the main line the train was made up of a number of individual cars and a five car articulated group. The reduction in weight, as compared with two bogies for each car, was said to be about 10 per cent; it was also stated that the train friction was reduced. A noticeable feature on the main line train at high speed was the smooth running of the group; the riding was exceptionally good and noticeably better than individual care in the same train.

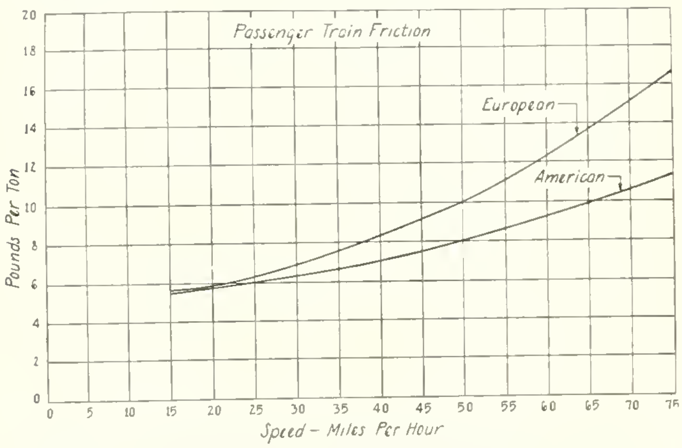
Types of Drive for Electric Locomotives

In the brief reference to electric locomotives, the motor car and steam locomotive were mentioned as prototypes which have influenced the trend of electric locomotive development. To elaborate, there are at least seven general designs of driving mechanisms or methods of motor mounting under which electric locomotives may be classified. These different classes may be briefly described as axle geared, quill geared, outside geared, axle gearless, quill gearless, direct connected side rod and geared side rod.

Each of these methods of drive, with the exception of the outside gear, are employed in this country. In

England the axle geared drive has been most generally used, but there has been completed recently a high speed locomotive for the North Eastern Railway equipped with the quill geared drive. The side rod drive does not seem to have met with favor; the following reference to side rod drive is quoted from a paper by Sir Vincent Raven (North East Coast Institution of Engineers and Shipbuilders, Dec. 16, 1921):

"On the Continent, notably in France, Switzerland, Italy, Germany, Austria and Sweden, the connecting rod drive in one form or other is almost universal. Up to the present electrification in these countries has been carried out mainly on the single-phase or three-phase system and Continental engineers consider that the additional complications caused by the introduc-



CURVES SHOWING RELATIVE FRICTION OF EUROPEAN AND AMERICAN PASSENGER TRAINS

tion of cranks and coupling rods are more than compensated for by the advantage of having a free hand with the motor design.

"A large number of designs have been worked out. Some have proved quite satisfactory, others have given rise to a good deal of trouble. In most cases the trouble has been eliminated by strengthening up special parts such as crank pins, Scotch yokes, etc., and by introducing a certain amount of flexibility into the connections between the motors and the crank shafts."

The mechanism of the motor driven side rod drive needs to be maintained in close adjustment and may reasonably be expected to require more attention and have a higher cost of maintenance than some of the other methods of transmitting power to the drivers.

The transmission of power from a motor driven crank, whether direct connected or geared, introduces strains in the connecting mechanism somewhat different from those which occur in a steam locomotive. With the best adjustment and with operating clearance only in the bearings, the motor driven connecting rods on either side transmit alternately the power through 90 degrees, except for such spring of the parts as may cause the rods to work together for a brief interval. As this transfer of the power from one rod to the other takes place at about 45 degrees from the dead center, the pins, connecting rods and included frame will be subjected to the full strain of driving when the crank is at an angle of about 45 degrees. If the two sides are not in even adjustment this angle may be even less.

Aside from centrifugal forces and the shock due to lost motion in the driving mechanism, the stress in the rods, pins and frame of a steam locomotive is limited and may be predetermined from the size of the cylinder and steam pressure. With a motor driven crank the stress is dependent on the crank angle and is affected by the adjustment of the mechanism.

As an extreme illustration, one side of a steam locomotive may be stripped and with the other side on dead center the throttle may be opened wide without damage to the locomotive. Under the same conditions with a motor driven crank, the resultant toggle action would set up enormous stress and undoubtedly wreck some part of the mechanism involved.

There is, further, an irregularity in the angular rotation of the crank with respect to the driving wheel which creates a superimposed stress on the driving mechanism, and which may be the cause of very disagreeable vibration should the natural period of the rotating mass involved happen to synchronize with the nodal points of angular variation. The effect of this irregularity in relative uniformity of rotation of the crank and wheel is more in evidence in some forms of side rod drive than others. The most severe case observed was on a direct connected locomotive with a V arrangement of connecting rods which ran with but little vibration, except at the critical speed when a knock developed which sounded as if the crank shaft was broken or being struck by a steam hammer. As this irregularity is due to the play in the bearings and the spring in the parts, it cannot be entirely eliminated in practical operation, but it may be minimized by maintaining the alignment and close adjustment of the bearings. It is obviously desirable to diminish the shock by cushioning as much of the rotating mass as possible.

Mr. H. Parodi, Chief Electrical Engineer of the Paris Orleans Railway, in the Revue Generale des Chemins De Fer, of March, 1922, has written of the vibratory characteristics of side rod drive and described the method he employed to improve the operation by the introduction of springs, permitting angular movement between the mass of the motor armature and the crank shaft.

The accompanying illustration shows graphically something of these characteristics of side rod drive. To better illustrate the action, the mechanism is assumed to be inelastic, the pin bearings of the rods are

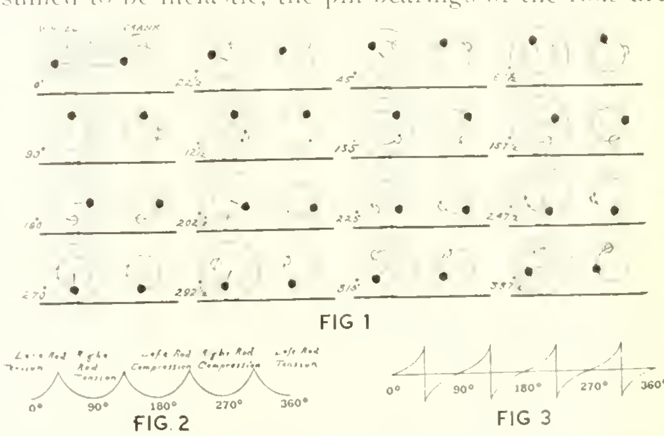


FIG 1

FIG 2

FIG 3

FIG. 1. DIAGRAM SHOWING THE ACTION OF SIDE ROD DRIVE AND THE EFFECT OF CLEARANCE IN THE BEARINGS, ON THE RELATIVE ANGULAR POSITION OF THE CRANK AND WHEELS

FIG. 2. CURVE SHOWING CHARACTERISTIC OF THE CHANGE IN ANGULAR POSITION OF THE CRANK WITH RESPECT TO THE WHEEL.

FIG. 3. CURVE SHOWING CHARACTERISTIC OF THE ANGULAR VELOCITY OF THE CRANK WITH RESPECT TO THE WHEEL

shown with exaggerated clearance, and the ordinates of the characteristic curves are greatly out of proportion. In reality, the value of these ordinates is dependent upon the working clearance in the bearings together with the inertia of the rotating masses, and whatever may be their actual value, the character of the action calls for its consideration in the design of motor driven side rod mechanism. Furthermore, the arc of action and the sharp angles of the characteristic curves as shown would be modified by the spring in the connecting parts.

There appears to be an increasing interest on the Continent in other methods of drive requiring less attention and maintenance. The Paris Orleans Railway have been operating axle geared locomotives in their Paris Terminal for more than twenty years and have recently ordered 200 of this type for local passenger and freight service on their main line extension. Over 100 locomotives of similar type are being built for the Midi and the State Railways. Locomotives with the same type of drive are also being built for the Spanish Northern Railway.

The electric locomotives on the Italian Railways are mostly of the direct connected side rod type. The workmanship and finish of these locomotives is exceptionally fine, so good in fact from our point of view that we might consider it an extravagance. They are well maintained, are giving good service and many additional locomotives have been built from the same design.

The electrification of the railways in Switzerland has been very well carried out and they may well take pride in their construction and equipment. The Swiss Railways have a variety of locomotives which are principally of the geared side rod type. The finish and workmanship of these locomotives is excellent, and they are very fine examples of geared side rod construction.

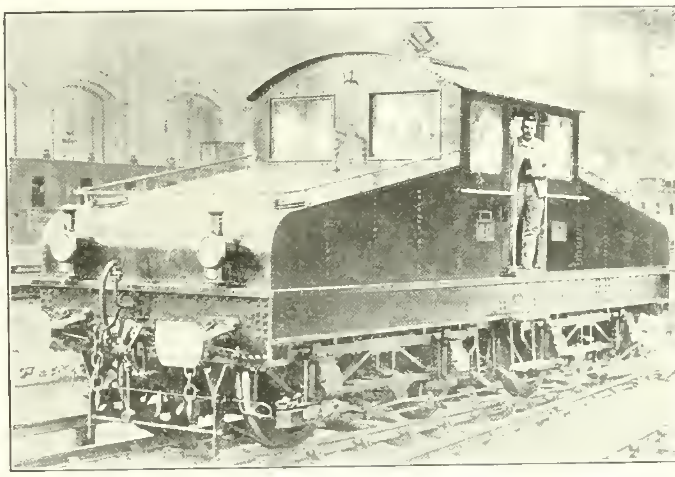
An interesting departure from side rod drive is a Swiss locomotive having the novel design of an outside geared drive which is being given a thorough service trial with a number of locomotives. These locomotives have an inside frame the same as a steam locomotive, the motor being carried on the frame directly over the driving wheel. The armature pinion is located beyond the outer face of the driver. The gear case is attached to the locomotive frame and is a strong structure provided with a pin in the center on which the gear revolves. The gear is carried about 3 in. from the outer face of the driver and within the gear is a system of balanced links which engage with the two pins projecting from the driving wheel. These links are so designed as to provide for independent movement of the gear and driver in any direction while still maintaining their relative uniformity of rotation. This locomotive runs very smoothly without any characteristic vibration, and the more general use of this type of drive on the Swiss Railways may reasonably be expected. These railways have also in trial service a number of locomotives with geared quill drive.

The braking equipment of European trains is quite different from our almost universal practice. Their passenger trains are equipped with power brakes of either the vacuum or pressure type and usually with two brake shoes per wheel. As there are several different braking systems in use, it is necessary in some instances to equip through cars, which run over different railways, with more than one system. In the trans-European service to Constantinople it is said that each car has to be equipped with four different braking systems to conform with the regulations en route.

Power brakes are seldom used on the freight trains and some of the freight cars have no brakes whatever. In many of the freight yards there will be found wooden wedges, which are for the purpose of chocking the wheels to hold the cars in place. The hand brake attachment to the braking system is usually through a screw and nut, instead of the chain and brake staff we commonly use. In some instances the brakes are applied only by a lever extending alongside. To handle freight trains on grades, where the brakes are necessary to control the speed, it is customary to provide a brakeman for every four cars. In ordinary freight movements the braking is done entirely with the locomotive.

Current Collectors

The sliding contact for current collection from overhead lines is almost universal on the Continent, for both tram cars and locomotives. Two triangular tubes of brass or copper are used for the contact on many of the Italian three phase locomotives, and triangular blocks of carbon are used on some of the direct current lines; but generally for tram cars and single phase locomotives the collector is an aluminum bow of U shaped section with a groove for lubricant.



60-TON AXLE GEARED ELECTRIC LOCOMOTIVE WHICH HAS BEEN IN SERVICE ON THE PARIS-ORLEANS FOR 20 YEARS

In locomotive service it is the practice to use two of these bow collectors on each locomotive, and because of the soft material the pressure against the conductor is limited to about 8 lb. With this light pressure some arcing might reasonably be expected and is observable when collecting from a single wire. In some places two conducting wires with interspaced hangers are used, which is better for current collection than a single wire as it provides greater flexibility and doubles the collection contacts. Where the double wire construction had been used there was no observable arcing at the collector. While the aluminum bow serves its purpose well for collecting the 100 amperes or more for which it is used, it would not be suitable for collecting current of any great magnitude.

Collectors of this type would by no means serve for the Chicago, Milwaukee & St. Paul locomotives, on which the current ranges from 800 to 1,200 amperes. The collector used with these locomotives has two separate, flat, copper contact surfaces, while the overhead system has doubled wire conductors with interspaced hangers. This provides four independent contacts in parallel, each of which are 4½ in. long so that theoretically the aggregate contact is a line 18 in. long. The pressure of the collector against the conductor is about 30 lbs. The relatively large amount of current taken by these locomotives is collected with no observable arcing as the continuity of contact is well ensured and the contact surface is of adequate capacity.

Any appreciable arcing at the contact between the collector and conductor is unquestionably more destructive to both than the wear that occurs from mechanical friction. Continuity of contact must be maintained if destructive arcing is to be avoided and the design of the collecting system should be such as will best ensure this continuity.

After investigating the various systems of railway electrification, a number of the European countries have established regulations in favor of a particular system for the electrification of their steam lines.

France, Belgium and Holland have decided in favor of 1,500 volts direct current. The overhead system of conductors will, presumably, be used in these countries with but few exceptions. There was some discussion in France as to whether 1,500 volts should be the generated or the average voltage of the system. It was finally ruled that 1,500 volts referred to the generated voltage, but that a maximum tolerance of 5 per cent would be allowed. There are no electrified railways of importance in Belgium and no projects under immediate consideration. In Holland an initial electrification is being undertaken between Leyden and The Hague, this being a portion of the main line that will ultimately be electrified between Amsterdam and Rotterdam.

England has also decided in favor of 1,500 volts direct current, except in special cases, of which the London, Brighton and South Coast Railway is an example. This railway is partially electrified with single phase, and it is proposed to complete the electrification with this system.

It is presumable that a 1,500 volt third rail will be quite generally used in England. The Lancashire and Yorkshire Railway have been operating over 20 miles of third rail at 1,200 volts with success for some seven years. The North Eastern Railway have been operating 600 volts third rail for something over 15 years, and have a more recent electrification with an overhead system at 1,500 volts. The London and South Western Railway have a 1,500 volt third rail under consideration. The South Eastern Railway, which runs near the Greenwich Observatory, are proposing to use two third-rails with 3,000 volts potential between them, but with the generating and motive power equipment connected in three wire relation to the track so that the voltage between each rail and ground will be only 1,500 volts. The purpose of this double rail arrangement is to eliminate currents in the earth which might affect the observatory instruments.

There has been no official decision in Spain as to the system of electrification for their steam railways. There is in operation a short line equipped with the three phase system. An important electrification on the Spanish Northern Railway over a mountain division in the north of Spain will soon be in operation with 3,000 volts direct current.

Switzerland has standardized the single phase system at 16 2/3 cycles for their principal electrifications, and this system is being generally extended, although 1,500 volts direct current is being used on some of the smaller railways. For other than single phase railways the standardized frequency is 50 cycles.

The Italian electrifications are almost exclusively three phase, although there are several lines equipped with 600 volts, and there is a recent installation of 4,000 volts direct current. Consideration is being given to a thorough trial of 3,000 volts direct current in the central portion of Italy south of the present zone of three phase operation.

Germany is continuing the use of single phase for steam railway electrification, although it was stated that 1,500 volts direct current would presumably be employed for heavy multiple unit and interurban service.

The subject of electric railway systems is under discussion in Sweden. The more important existing electrifications are equipped with the single phase system at 16 2/3 cycles. As the standard frequency for general purposes is 50 cycles, there appears to have arisen some question as to the expediency of generating and transmitting a particular frequency for the railways only. The more general utilization of natural resources and the better load factor resulting from diversity of use would seem to indicate an economic advantage in favor of generation at the standard frequency with substation conversion into whatever form of electrical power the railways may require.

The economy in fuel obtained by modern steam power stations and the many available sources of hydraulic power have contributed to stimulate greatly the electrification of the steam railways in Europe. Government endorsement of the projects has also been helpful in financing these enterprises.

Less Than One Per Cent of Steam Railways Have Been Electrified

The following list, compiled from available records, will give an idea of the extent of railway electrification throughout the world. It includes the steam railways which have been electrified or are in process of electrification, but not the steam railways on which multiple unit trains are being used exclusively, or electric railways which were not formerly operated by steam.

Steam Railway Electrification

	Route Miles	No. of Elec. Locos.
United States	1,607	375
Switzerland	661	156
France	602	338
Italy	650	309
Germany	550	49
Sweden	237	44
Cuba	180	18
Austria	340	42
Africa	174	77
Chile	154	42
England	129	12
Spain	48	17
Canada	49	9
Japan	39	42
Norway	39	37
Mexico	30	10
Brazil	26	16
China	25	13
Java	25	5
Total	5,565	1,611

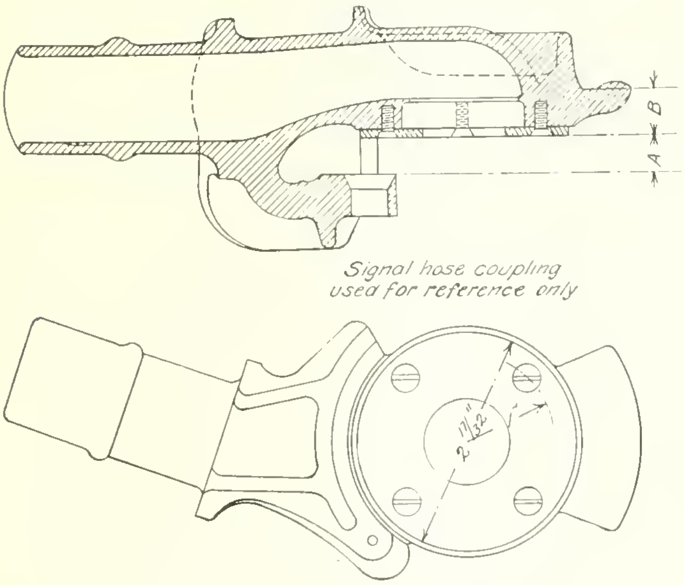
This is less than 1 per cent of the railway route mileage of the world. Conceding the efficacy of the steam locomotive for much of the world's service there still remains a very large mileage which could be advantageously electrified. In the execution of this great undertaking we have many engineering economic problems, the solution of which demands the cordial co-operation of all who are engaged in the furtherance of railway transportation.

Railway Shop Kinks

Some Special Devices Used for Testing Air Brake Equipment

Gauge for Signal Hose Coupling

This gauge is used to determine the wear of signal hose coupling. The face of the coupling is finished and to it a steel plate is fastened by countersunk machine screws. The special dimensions of the gauges are given in the accompanying table. These gauges or couplings are used for reference only, and are given the dimensions shown in the following table:



GAUGE FOR SIGNAL HOSE COUPLING

Coupler	Thickness of Plate Inch	Type	A Inch	B Inch
No. 4........	13/128	H.P. 4	55/128	65/128
No. 6........	17/128	H.P. 4	51/128	69/128

Coupler Gauge for Standard Air Brake Hose Couplers

The gauge which is here shown is one developed by the Westinghouse Air Brake Co. for the inspection of old unmounted hose couplings. Gauge No. 1 is the minimum and No. 2 is the maximum gauge, the special dimensions of which are given in tabular form, at the end of this description.

In using these gauges, No. 1 must enter the coupling being tested and No. 2 must not enter.

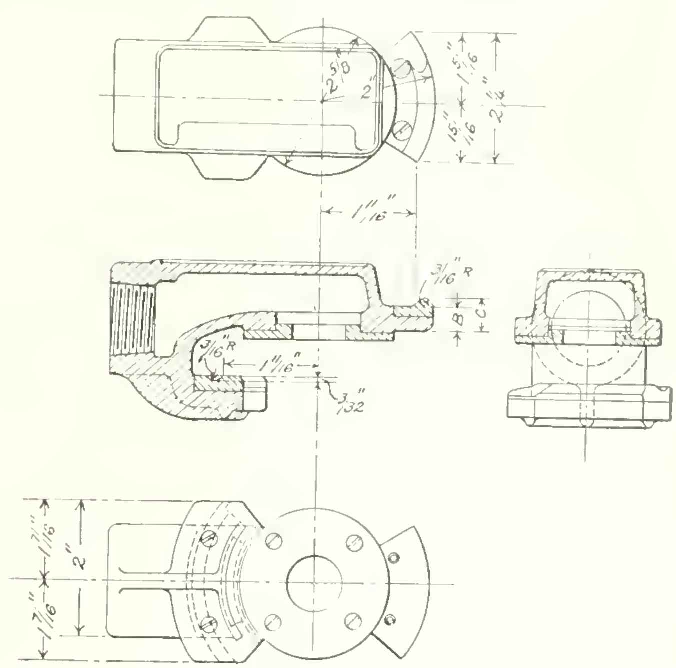
When gauging old couplings they should be adjusted so that they will couple with the minimum gauge by adjusting the distance *A* by means of a hammer or wedge. Finally new gaskets should be applied to couplers before being put into service.

	Dimensions in Inches		
	A	B	C
No. 1.............	79/128	89/128	101/128
No. 2.............	75/128	93/128	105/128

Clasping Blacksmith's Tongs

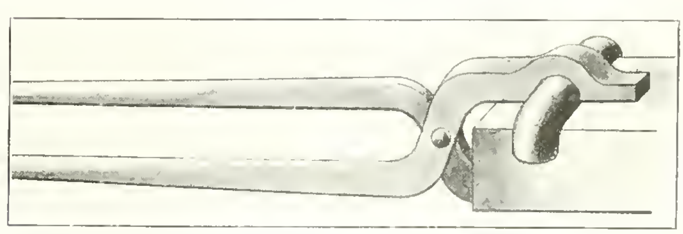
A blacksmith frequently has occasion to hold a square or heavy bar that is apt to turn, when an attempt is made to hold it with an ordinary pair of flat tongs, and grooved tongs that will fit the piece are not available.

The accompanying illustration shows a convenient tongs that may be made available for any size of work. The bottom jaw which is, in the illustration, concealed by the work, has a plain flat face. The upper jaw has a groove cut across it into which a round bar can be laid. A convenient size is to make it to receive a ¾-in. round,



COUPLER GAUGE FOR STANDARD AIR BRAKE HOSE COUPLING

and have the groove so cut that the round bar will stand out below the surface of the jaw, so that it, and not the face of the jaw will have a bearing against the work.



CLASPING BLACKSMITH'S TONGS

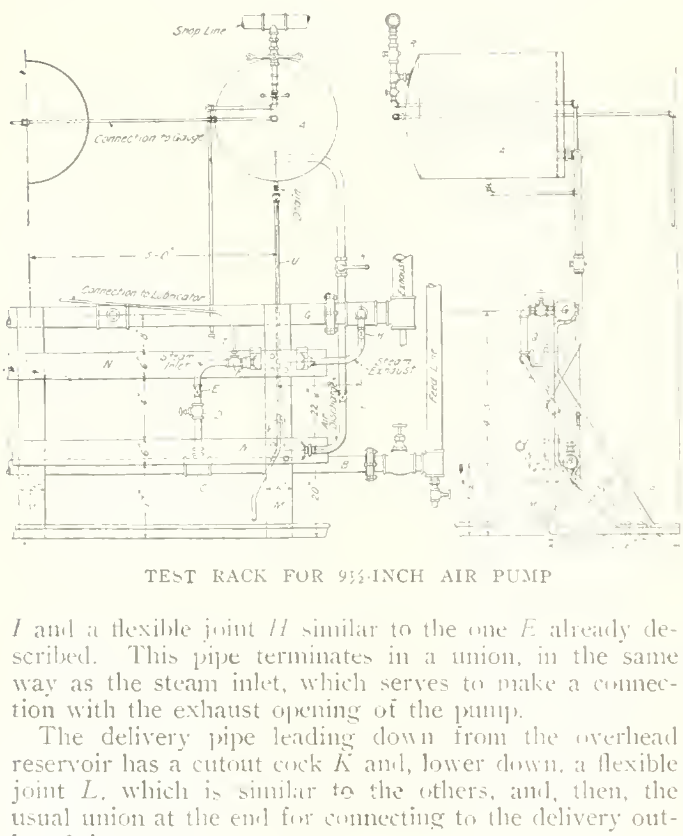
Then, when a heavy piece is to be held, a piece of round iron is cut off and bent to a U-shape to fit over the work. It is laid on the bar and held down by the tongs as shown. In this way, one pair of tongs can be made to hold a variety of widths.

Test Rack for 9½ in. Air Pump

While this test rack for a 9½-inch air pump shows space for one pump only, it is evident that it is merely a matter of extension of the base and a multiplication of the rack framing to accommodate as many pumps as may be desired.

In the particular installation that is here illustrated the main reservoir, *A*, is located overhead and out of the way. Steam is brought down from the shop steam pipes through the vertical feed line and then along back of the racks through the pipe *B*. At each rack there is a tee *C* from which a pipe leads up to a globe valve *D* which serves as a throttle valve for the pump. A nipple is screwed into this globe valve, and to this is secured a flexible joint *E* which may be made from a piece of rubber steam hose, or preferably of a piece of flexible metallic tubing. This, in turn, delivers to a bent pipe which carries a union at its free end by which a connection is made to the steam inlet of the pump. Set into this pipe is a tee *F* which serves to make the connection from the lubricator, the pipe to which is shown leading off to the left.

The main exhaust pipe *G* runs along at the back, and above the top of the rack that serves to hold the pump. There is a side connection to this pipe with a globe valve



TEST RACK FOR 9½-INCH AIR PUMP

I and a flexible joint *H* similar to the one *E* already described. This pipe terminates in a union, in the same way as the steam inlet, which serves to make a connection with the exhaust opening of the pump.

The delivery pipe leading down from the overhead reservoir has a cutout cock *K* and, lower down, a flexible joint *L*, which is similar to the others, and, then, the usual union at the end for connecting to the delivery outlet of the pump.

With these three pipes each of which is fitted with a flexible joint, it is possible to make the connections to the pump and take up any variations in position without putting any strain on the piping.

The rack for holding the pumps is made up of vertical pieces *M* of 1½ inch, by 6 inch flat steel. These are bent to an *L* shape and are bolted to the floor and tied together horizontally by ¾ inch by 6 inch bars *N* and braced at the back by the diagonal braces *O* and *P* which are also of ¾-inch by 6 inch flat steel. This makes a very rigid and substantial construction.

The pumps are not bolted to the rack but are carried by the hangers *Q* which are S shaped and made of ⅝ in. by 2½ in. steel. These hangers simply slip over and hang on the horizontal tie bars *N* and the pump lugs set in the opening at the front.

It is, therefore, a simple matter to set up and detach a pump. It is simply lifted on to the hangers and the three connections made, when it is ready for the test.

The main reservoir *A* is also connected to the main air line of the shop so that when the pump is running under pressure the air compressed is not wasted but can be utilized for shop purposes. A cut off valve *R* with a lever connection and chains reaching to the floor, for its manipulation, is fitted in the connecting pipe.

Below the tee in this connecting pipe there is another cut out valve *S* fitted in like manner with a lever and chain connections for floor manipulation. This valve opens and closes communications to a small pipe leading down to a choke opening, by means of which a capacity test of the pump can be made.

When simply pumping the valve *S* is closed and *R* is opened. Air is then delivered into the main shop line and the pump will be working against the pressure therein. Then, when a capacity test is to be made, the valve *R* is closed and *S* opened and the delivery is made through the orifice *T* with a pressure measured by a gauge in the pipe leading off from the reservoir, as shown.

Drainage of the reservoir is provided through the pipe *U* which may be closed or opened by the cock *V*.

The whole rack is very simply and easily constructed, requiring almost no work beyond that of a drill and pipe fitter, and can be extended indefinitely to accommodate any number of pumps.

Cleaning Brass Castings

The cleaning of castings is one of the trifles of foundry work that is exceedingly troublesome at times. It is easy enough to do where there are no cores and the pieces can be dumped into a rattler and cleaned. But, where cores are in small pieces, it takes time and costs some money to get them out. But it is a very easy matter with brass castings.

Just before they cooled off, plunge them in water and the steam, generated by the hot metal, will blow the cores out as cleanly and effectually as though the interior had been subjected to a special internal tumbling.

Fuel Association Convention Program

Julius Kruttschnitt, chairman of the executive committee of the Southern Pacific Railroad, will deliver the opening address at the convention of the International Railway Fuel Association to be held at the Hotel Winton, Cleveland, Ohio, on May 21-24. An address will also be made by T. K. Maher, president of the Maher Collieries Company. A partial list of the papers to be presented is as follows: Extension of Locomotive Runs, by C. B. Peck, associate editor, *Railway Age;* Considerations Covering Use of Oil as a Locomotive Fuel, by M. C. M. Match, mechanical engineer, M. K. & T.; Fuel Saving Aspect of Boiler Water Treatment, by C. R. Knowles, superintendent water service, Illinois Central; Value of Individual Fuel Performance Records, by L. G. Plant, associate editor, *Railway Review;* Standardization of the Coal Business, by George H. Cushing; The Other Ten Per Cent, by R. S. Twogood, assistant engineer, Southern Pacific; Economic Aspects of the Fuel Oil Situation, by C. E. Beecher, U. S. Bureau of Mines; Economy in the Heating of Stations and Buildings, by Prof. R. W. Noland, Purdue University; Incentives for Promoting Fuel Economy, by O. S. Beyer, Jr.

There will also be a topical discussion of the paper on the Effect of Tonnage Rating and Speed on Fuel Consumption presented by J. E. Davenport at the 1922 convention.

Something New in Friction Gear

By W. E. Symons

King Solomon once said, "There is nothing new under the sun," and while this is true in a sense, yet it is not a fair appraisement of the activities of civilized man, and particularly so when applied to the wonderful progress in transportation.

Without going back to the more remote periods, we might start from the earlier history of water transportation or marine engineering, and recall the utterance of a man who at that time was recognized as the leading engineer of the English speaking world, with respect to propelling a ship across the Atlantic ocean entirely by steam, when he disposed of the proposition by saying that. It was just as feasible to attempt to drive a ship to the moon (238,000 miles) as to talk about crossing the Atlantic ocean wholly by steam power. No doubt, the learned gentlemen thought perfection had been attained, and that there was "nothing new under the sun." This distinguished engineer, a few years later, learned with much chagrin that in the cargo of one of the first steamships to successfully cross the Atlantic ocean wholly by its own steam power was a large shipment of technical literature, including several sets of standard engineering works of which he was the author, and in which he had proven conclusively, to his own satisfaction at least, the absolute impossibility of doing exactly what had been quite easily accomplished.

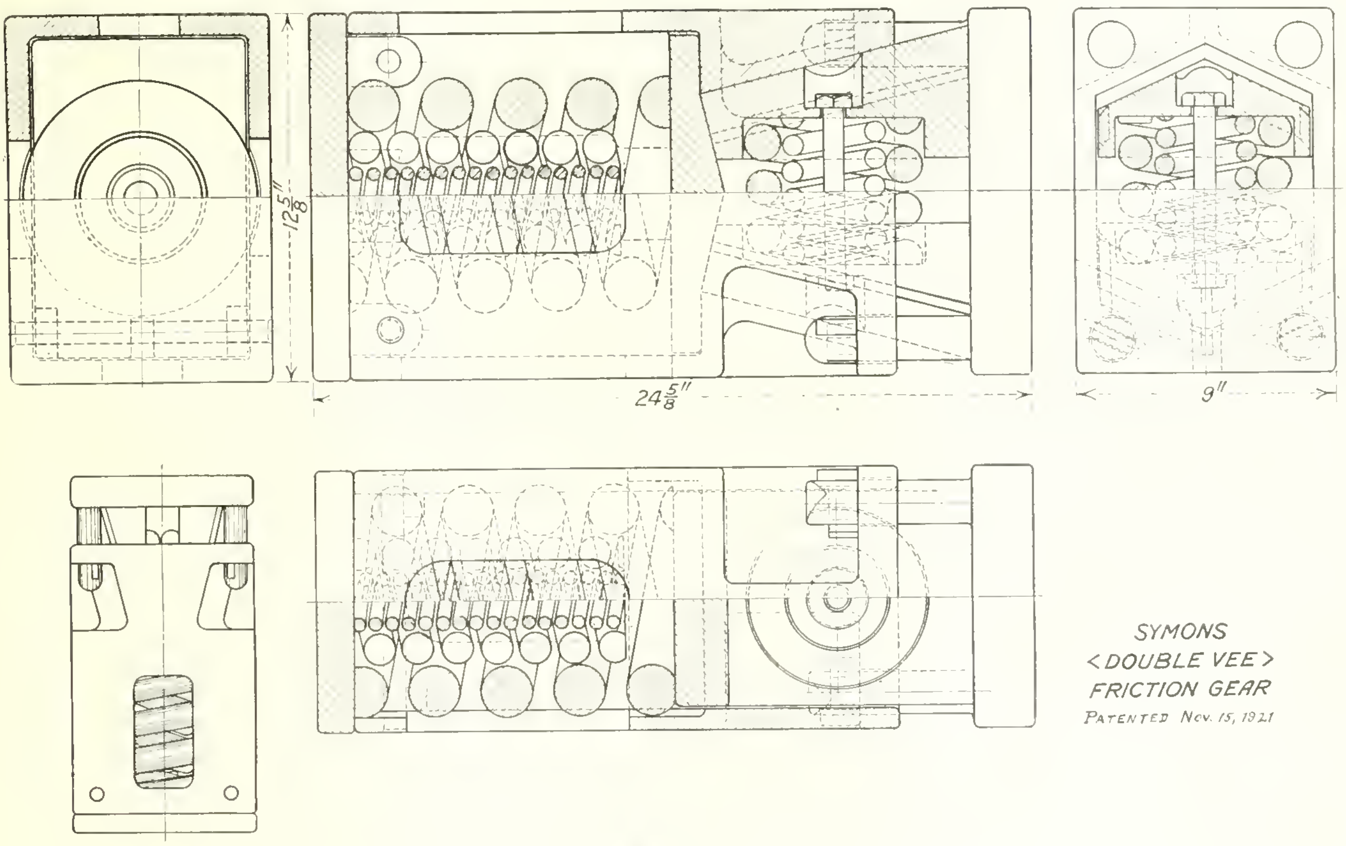
Again we are told that in the early history of our republic, when after letters patent had been issued to several hundred inventors of different devices, it was seriously proposed to close up the patent office, on the ground that as nothing more would ever be invented it would be wrong to tax the people to defray the expense of a department that had absolutely nothing to do.

If some of these gentlemen could only have a bird's-eye-view of the developments since their time, they would of course be compelled to admit having been "mighty poor prophets."

Coming down to the subject matter of draft gear, it is a long journey from a hook bolt in the wooden end sill of our first cars that were horse-drawn to the present coupler and draft gear on 50 to 75-ton steel cars, and although the coupler as a complete self-contained unit seems to have almost, if not quite, reached a stage of perfection, the draft gear has not kept pace with coupler development.

Some 30 years ago Mr. George Westinghouse conceived the idea of a friction gear, or shock absorbing device to absorb the energy or forces instead of their being stored up in springs under compression to play havoc with cars and contents when brakes were released, and invented a device of which upwards of one million have been applied to cars on railways in this country, and no doubt has saved the railways millions of dollars.

As a result of many years of thought, study and experiment, there has been developed quite a crop of friction draft gears, in fact without a careful check of patent office records it would not be safe to hazard a guess either as to the number patented, or as to their relative merits, for while many bear evidence of inventive genius and engineering skill, a great number might be called impossible freak ideas.



DETAILS OF THE SYMONS FRICTION DRAFT GEAR

In making a summary of the development of railway equipment and integral parts of the completed unit, one cannot fail to observe what might be termed lack of consistency in question of design, and this is nowhere so conspicuous as in draft gear, for while there is almost universal agreement on standards as to many of the most important parts of freight cars, there is about as complete disagreement as to a standard friction gear as could exist between a Hindu and a Christian on the question of religion.

Too Many Parts—Not Self-Contained Units

One striking feature to many students of locomotive and car design is the number of loose parts in many gears, and that most all are *not* complete self-contained units, many of them might be classed, when received by the purchaser, as bench hardware, as the parts are loose and must be fitted together and means provided for retaining them in proper relation for service, while most others

NEW DESIGN OF FRICTION GEAR

that are encased or fastened together are not fully complete, as they do not fill the standard gear pocket space, and the purchaser must, in order to complete the job and have a finished gear, furnish one or two follower plates.

There are, so far as the writer is aware, but three gears now on the market which are complete self-contained units with *no* loose parts and that fill the standard A. R. A., gear pocket 9 x 12⅝ x 24⅝ in.

If the manufacturer of even a less important part of a locomotive or car than a friction gear were to offer loose parts for assembly or an assembled unit requiring an additional piece or pieces to be furnished by the purchaser in order to complete the job, scant consideration would be accorded, on the well established principle, that so important an integral part of a locomotive or car should not only be designed and completely built, but that responsibility for each part or piece in the complete unit should rest with the manufacturer. In other words, it is too important a part of equipment to permit the question of divided responsibility to be raised in the event of unsatisfactory service.

After more than 25 years' close contact with most all features of equipment design, operation and maintenance, the writer some three years ago made a special study of draft gears, particularly friction gears, which resulted in working out the design shown in the accompanying illustrations and designated "The Double Vee," this being descriptive of the friction face of wedges and casing grooves in which they function, there being no other design in which this feature is embodied.

The manufacturer's claims for this gear are that it is:

The only complete self-contained unit with two friction wedges requiring no follower plate.

The only device in the design and operation of which the friction wedges are in fixed contact on two angles of outer faces, at both ends with integral members, and with compound friction feature at one end.

The only self-contained unit standard to A. R. A. pocket 9 x 12⅝ x 24⅝ in., with so few friction, or other parts.

The only device of high kinetic static and dynamic capacity, with friction wedges of an obtuse angle, and spring capacity of 40,000 to 50,000 lbs., in which the slightest movement develops both spring and friction energy.

The only complete self-contained unit, in the manufacture and maintenance of which no special machinery is required.

The only complete self-contained unit, interchangeable on all kinds of railway equipment, and equally well adapted for use in many other fields where a dependable high capacity shock absorber is required.

In a test of one of these gears, the following results were obtained:

Travel in inches	Capacity in Pounds
½"	32,000
1"	56,000
1½"	84,000
2"	201,000
2½"	233,000
Closing	285,000

More than 400,000 lbs. was then applied with no injury to casing.

The following tabulation will serve to bring out more clearly certain essential features of different gears:

	Per Set of Two Units					Spring Value Capacity and Closing Speed			Complete
Class	No. of parts	Friction parts	Loose parts	Follower plates	Weight, lbs.	Compression spring value	Static capacity	Closing speed, m.p.h.	self-contained unit
A	24	10	none	none	850	48,000	...	5	yes
	52	14	none	none	856	45,000	..	4.[illegible]	yes
	66	48	none	none	940	36,000	..	5.23	yes
B	56	24	2	2	878	21,300	..	4.24	no
	64	24	4	4	684	25,300	.....	3.59	no
	36	8	4	4	834	42,000	..	4.33	no
	44	10	4	4	840	38,000	....	3.59	no
	66	16	12	2	1,026	28,000	..	3.50	no
	16	10	12	2	788	24,000	......	4.33	no
	44	10	12	2	870	30,000	......	4.40	no
C	40	18	41	..	880	30,000	..	3.86	no
	26	8	26	..	760	43,000	..	3.52	no
	20	10	20	..	780	30,000	..	3.12	no
	134	120	134	..	960	......	.....	2.98	no
Average	49	23.5	24.5	..	853	33,830	......	4.	..

Class-A. Includes only complete self-contained units with no loose parts whatsoever, a machine that alone fills the gear pocket.

Class-B. Includes gears requiring one or two follower plates, and some having other loose parts.

Class-C. Includes gears principally fabricated by the purchaser from loose parts and pieces. Center sills, coupler yoke, and draft lugs constituting a receptacle for working parts.

It is safe to predict, that any disinterested engineer or railroad man who has given this subject the attention and study it deserves, would, if asked which class or group appeared to embrace the most desirable fundamentals in a friction gear would answer Class A.

If it were not for the undesirable, or we may say dangerous, feature of excessive shock in long freight trains the problem of a slack absorbing device would be much simplified. With a permissible coupler travel of 5 or 6 inches, a pneumatic or other design, could be successfully employed, but when we stop to consider that with only 2-9/16 in. travel, on a 50-car train we have more than 20 ft. of slack, with an 80-car train more than 30 ft., and with 100 cars 41 ft. of slack, it is clear at a glance to those with an elementary knowledge of train operation that to increase coupler travel of freight cars is to invite increased hazard to train movement.

Much stress has been laid on the interchangeability of parts of locomotives and cars as this has much to do with storehouse stock on hand or idle money invested, also on the time equipment may be held for new parts complete, or integral parts of a device. Gears of this design, capacity and dimensions could be applied to or interchanged with all kinds of freight equipment; portable cast steel, solid structural steel, or concrete bumping posts; recoil mechanism for heavy artillery or other high duty shock absorbing service.

These gears are being manufactured by one of the oldest and most reliable steel foundries in this country, and furnished for application under the most exacting conditions of service on tank cars, and heavy trunk line railways, and it is confidently expected the results from actual service will be such as to more than justify the title or caption of "Something New In Friction Gears."

How Railroads Are Improving Their Service

In an address before the annual dinner of the Transportation Club of St. Paul, Minnesota, on January 30, Mr. Ralph Budd, president of the Great Northern Railway Company, discussed way in which railroads are making and can further make improvements in transportation service and reductions in operating costs. Among other things he said:

"The reduction in the item of labor cost does not necessarily mean lowering the wages of the employes, but does, of course, mean accomplishing more from a given expenditure for labor. Something can be accomplished in this direction without reduction in wages; by more efficient performance of the individual employe; by keeping abreast of the development in modern shop methods, tools and appliances; by further perfection of motive power and cars; by making improvements in terminals, and by making grade reductions and otherwise improving the roadbed. Such additions and improvements, of course, involve investment of additional capital.

"This emphasizes the need, which is encountered at every turn, for established credit in order to give the best service at the lowest cost consistent with prevailing conditions.

"Another way in which expenses can be reduced and the service improved is my making more intensive use of existing facilities. The economies made in this way have the special advantage of not requiring the investment of additional capital. Some of the things that may be done are as follows:

"(1) Heavier car loading.

"(2) Less detention of cars, including delays in loading and unloading, and in holding for inspection and diversion.

"(3) Faster car movement.

"(4) Improved car distribution.

"(5) Common use of terminals, etc.

"(6) Use of short routes for through business.

"(7) Further standardization of materials used in maintenance of road and equipment.

"(8) Elimination of duplicate and unnecessary passenger train mileage on long through runs while still maintaining or improving local service."

Cars and Locomotives Still to Be Delivered

Orders placed by the railroads for all classes of freight car equipment up to February 1, last, called for the delivery of 91,354 cars, according to reports filed today by the carriers with the Car Service Division of the American Railway Association.

Of that number orders for 23,022 freight cars were actually placed in January, this year, while the remaining represented cars ordered but not delivered during the calendar year 1922.

Coal cars under order on February 1 totaled 37,476, of which orders for 13,258 cars were placed in January. The remaining number constituted cars ordered but not delivered in 1922.

Box cars on order numbered 43,211, of which orders for 7,594 were placed in January. Reports also showed that 2,082 refrigerator cars were also ordered last month, bringing the total number ordered but undelivered on February 1 to 6,402.

Locomotives on order on February 1 totaled 1,507 compared with 1,445 on January 1, last, or an increase of 62 for the month. Of the total number of locomotives on order, freight locomotives numbered 1,022; passenger, 362, and switching, 123.

Pike's Peak Trip for the Air Brake Association Convention

Forecasting for the entertainment of those attending the Air Brake Association Convention in Denver, May 1 to 4, the management of the Manitou & Pike's Peak Railroad, the so-called "Cog Route," have advised the secretary's office that they will open up the road a couple of weeks earlier this year than usual to accommodate the convention people, providing a large enough party can be arranged to make the trip to the summit of that famous mountain. May 15 is the regularly scheduled opening date for the road, but if a party of 100 can be assured, the road will open up on May 3, and carry the party up and back for $4.00 per head. This rate of fare seems so reasonable for what one would get that persons making the trip would doubtless return to their homes feeling that they had been well repaid for making the trip. This seems an unusual opportunity for a healthful, educational day's outing to those attending who make the convention serve also as their annual vacation, and many will probably come to the convention prepared to enjoy the trip.

British Railway Reorganization

Marked progress has been made in the reorganization of the British Railways under the Railways Act of 1021. The most significant innovations provided for in the Act are: The reorganization of all lines into four large geographical systems; the periodical revision of traffic charges through the Railway Rates Tribunal; and the adjudication of railway labor problems through Central and National Wages Boards.

The reorganization of approximately 120 systems into four, aims at uniformity, efficiency, and economy of operating conditions as the logical means of achieving financial stability. The major groups, known as the Southern Railway Co., the Gerat Western Railway Co., the London, Midland & Scottish Railway Co., and the London & North Eastern Railway Co., were practically formed at the close of 1922. The first and last groups, having the approval of the Amalgamation Tribunal, are to operate finally as such from January 1, 1923. The second group awaits the approval of some few absorption schemes, and the third group is approaching complete amalgamation. Both may be antedated by the Tribunal to operate from January 1, 1923.

The first task in connection with the revision of rates has been the reclassification of merchandise into twenty-one instead of eight groups. The Act stipulates that charges shall be levied sufficient to provide annual net standard revenue equipment to the net revenue of 1913, allowance being made for additional capital outlay. Of any surplus above that net revenue, 20 per cent goes to the companies, while the remaining 80 per cent must be applied to benefit railway users, either in reduced charges or in more efficient service.

Several substantial concessions on rates were made during 1922. These, however, have so far brought relief in freight rates to few trades outside of the iron and steel industry. There the new rates range from 44 to 68 per cent above pre-war levels. Passenger traffic has had to wait for the opening of 1923 for its first appreciable cut in fares, the revised first-class rate at 2½d. per mile and third-class at 1½d. per mile making a uniform basis of 50 per cent over pre-war.

Though the decision of the National Wages Board in 1920, wages of railway employees were put on a new post-war basis that keeps them much higher in proportion to 1913 than the average level in other British industries. Wages at the end of 1922 were between 100 per cent and 125 per cent above pre-war scales, while the cost of living index stands at only 80 per cent over 1914.

Revenue Per Ton Mile Decreased 12 Per Cent

A report on revenue traffic statistics, prepared by the Interstate Commerce Commission for the month of November and for the eleven months of 1922, compiled from 162 reports, representing 178 Class 1 roads, shows that in November, 1921, the revenue per ton mile was 1.273 cents, compared with 1.1119 cents in November of last fall. This represents a decrease of about 12 per cent in the revenue per ton mile. Freight revenues in November, 1922, totaled $388,373,035, compared with $341,750,566 in November, 1921.

The number of miles which the average ton of freight was carried in November, 1922, was 184.04 miles and in 1921 about the same, or 184.47 miles.

Passenger train figures show that in November, 1922, the average number of miles traveled per passenger fare collected was 35.74 miles. In 1921 it was 34 miles. The revenue collected per passenger mile, including commutation revenues, in November, 1922, was 3.07 cents and in November, 1921, 3.10 cents. The average number of passengers per car in 1922 was 15.51, and in 1921, 14.75.

In the month of November, 1922, the number of passengers carried was 77,217,000 and in November, 1921, 78,164,000. The number of passengers carried in the eleven months of 1922 was 881,668,000, compared with 951,452,000 in 1921.

The average number of miles traveled per passenger in commutation service in November, 1922, was 13.90 miles, and in 1921, 13.79 miles. Excluding commutation service the average number of miles traveled per passenger was 54.39 miles in November, 1922, and in November, 1921, 49.99.

Julius H. Barnes States Needs of Railroads

At a special meeting of the Department of Transportation and Communication of the Chamber of Commerce of the United States, Mr. Julius H. Barnes, the president, said:

"There is necessity for the early adoption of a national transportation policy which shall provide for future expansion of commerce. In twenty years the railroad ton-miles have almost trebled. It is a question as to what the railroads will do the next twenty years, and how increasing volume will be cared for. Business men feel that there must be established a proper relation of service between railroads and waterways and motor transport.

"But beyond that, business men feel there must be developed a national treatment of railroads which will protect a proper public interest, and will also restore investing confidence by which the means of expanding facilities can be provided; and restored in railroad management a field which will attract a grade of business ability which its importance requires. * * *

"Government ownership and government operation in countries in Europe, and even in our neighbor of Canada, have written too clear a trail of losses and of restricted commerce for America to contemplate any such solution."

Stresses and Circulation in Locomotive Boilers

George L. Fowler, asociate editor of Railway and Locomotive Engineering and consulting engineer, delivered a lecture on "Stresses and Circulation in the Locomotive Boiler" before the students of Cornell University on the afternoon of February 23. The lecture was based upon the investigations of the speaker as to the deflections of staybolts in both rigidly and flexibly stayed boilers of the radial stayed and Wooten types. Investigations that were carried on in the Collingwood shops of the Lake Shore & Michigan Southern Railway, and in the Colonie shops of the Delaware & Hudson Co. The points regarding boiler circulation were based on the work done by Mr. Fowler in the Coatesville tests a number of years ago.

Railroads Used More Coal and Oil Last Year

A special report of the Interstate Commerce Commission, compiled from reports of 177 steam roads, shows that in November, 1922, these railroads used 9,736,000 tons of coal, compared with 8,115,000 in the same month a year ago. In the first eleven months of last year these railroads used 85,775,000 tons of coal, compared with 83,994,000 tons for the same period in 1921.

The consumption of fuel oil also increased. In November, 1921, 123,513,000 gallons of fuel oil were used and in November, 1922, 155,364,000 gallons. This represents an increase of 31,851,000 gallons, or 25 per cent. For the eleven months ended with November, 1922, 1,408,291,000 gallons of oil were consumed, compared with 1,300,307,000 for the same period in 1921.

Strains in Car Wheels Due to Combined Effects of Wheel Static Load and Flange Pressures

By J. M. SNODGRASS and T. H. GULDNER

The University of Illinois has issued a bulletin No. 134 giving further results of the investigation on the stresses and strains set up in cast iron car wheels, which has been conducted in connection with the Association of Manufacturers of Chilled Iron Car Wheels. This is the second bulletin issued in regard to the investigation, an abstract of the first on the Properties of Chilled Iron Car Wheels having been published in RAILWAY AND LOCOMOTIVE ENGINEERING in the issue of August, 1922.

The work reported in this bulletin sets forth the strains which may occur within the car wheel and the limitations

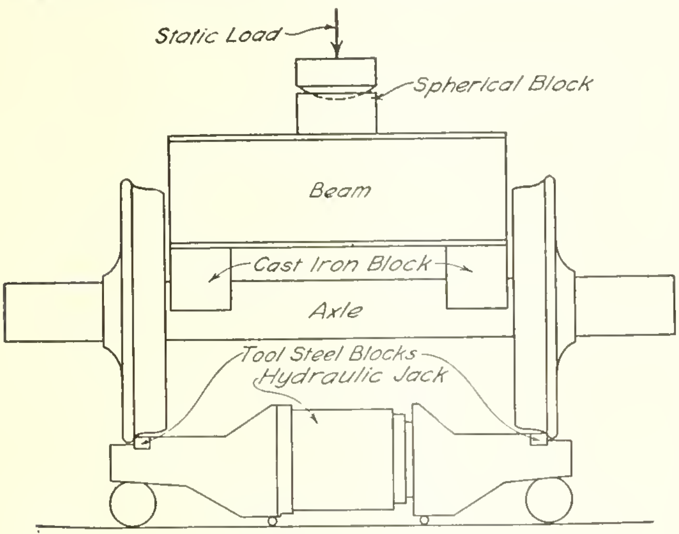


FIG. 1. METHOD OF APPLYING STATIC LOAD AND FLANGE PRESSURE

of the present designs, all with the view of improving the chilled iron car wheel and making it more satisfactory under present and under future service requirements.

The bulletin under consideration deals with the tests made to determine the strains caused by wheel fit, static load and flange pressure, taken both individually and collectively, and further to determine the ultimate strength of the flange of the chilled iron car wheel. The first part of the bulletin deals with the strains existing in a 33-inch, 840 pound, arch face wheel when subjected to the combined effects of mounting, static load and side thrust pressures. The remainder of the bulletin reports a series of tests made to determine the ultimate strength of the car wheel flange.

On a tangent track a train, due to lateral oscillations, impinges against the rails alternating from one side to the other. In traversing a curve centrifugal force tends to cause the car to hug the outer rail of the curve. In both cases the car wheel flanges which come in contact with the rail are a factor in transmitting the various forces set up within the car to the rail. In general the flange pressures produced in negotiating curves are the more severe so that the pressures arising on tangent track need not be considered. The flange by functioning in this manner is the primary cause of the following effects in the wheel itself. First, the pressure or force between rail and flange sets up internal strains and stresses within the body of the wheel. In the case of the wheel subjected to abnormal operating conditions the internal stresses may result in the failure of the wheel. Second, the pressure between rail and flange coupled with the rotation and sliding of the wheel on the rail results in a grinding or wearing action and in the consequent reduction in area and strength of the flange. Third, the rail pressure when of sufficient magnitude and, if acting on a flange materially worn, may cause the failure of the flange.

The problem of calculating the force between rail and flange under various conditions is an intricate one and as a problem in mechanics cannot be readily solved on account of the many variables involved. A fair estimate of the flange pressure, however, can be made by a method suggested by A. M. Wellington and added to by F. K. Vial.

Briefly, the latter method states the maximum flange pressure may equal one and one-half times the static load on the wheel. The use of this method probably gives higher values of flange pressure than would be attained in service and thus errs on the side of safety. Experimental methods have also been tried to determine flange pressures. An examination of the experimental methods used indicates that although flange pressures were measured, no evidence exists that they were the maximum pressures that would be encountered under the test conditions. Until more definite methods either analytical or experimental are devised it seems that the above mentioned method of estimating flange pressure is the most satisfactory at present available.

With respect to calculating either the strength of the flange or the ability of the plates of the wheel to withstand internal stress due to flange pressure no satisfactory analysis has as yet been made and recourse must be had to experimental methods to establish such facts in this connection as may be possible.

The testing equipment used to apply the loads for determining the combined effects of wheel fit, static load and flange pressure is shown in figure 1. It consists of a 200-ton hydraulic jack supported on rolls which in turn are supported on the bed of a 600,000 lb. testing machine. The specially made castings fastened to each end of the jack have a hardened tool steel block inserted near their ends. The upper side of this block has a contour similar to the head of a rail. A pair of wheels previously mounted on an axle rests on these steel blocks. By means of the spherical block, beam and two cast iron blocks the static load is transmitted to the axle, thence through the wheels and on down to the bed of the testing machine. After applying the static load of the desired magnitude, the fluid pressure is adjusted in the hydraulic jack to give the required flange pressure. The strains due to the various combinations of load were determined by means of a Berry Strain Gage.

One 33 inch, 840 lb. arch face wheel was tested for the combined effects of wheel. The wheel was prepared with 2 inch strain lines as shown in Fig. 2. The gage lines were numbered from hub to tread, the numerals were suffixed with either R or T signifying that the gage line was in a radical or tangential direction respectively. After preparing the wheel with gage lines the initial or before load readings were taken with the strain gage. The wheel was then pressed on the axle and a second set of strain gage readings taken. As previously explained the difference between the initial readings and those taken after mounting are the strains produced through mounting the wheel on its axle. After having determined the strains caused by the wheel fit, a second wheel was pressed on the axle to serve as a dummy in the application of additional loads to the 840 lb. arch face wheel. The two wheels, the hydraulic jack and the remainder of the apparatus were then assembled in the testing machine as shown in Fig. 1. A net static load of 13,050 lb. or approximately half of the allowable service load was then applied to the 840 lb. arch face wheel and a third series of strain readings taken. The difference between these readings and the initial readings represent the strains due to the combined effect of wheel fit and a 13,050 static load. In a similar way the dual effect of wheel fit and a 25,450 lb. static load (allowable service load) was determined. After having determined the combined effect of wheel fit and the 25,450 lb.

12 in simple compression. The data thus obtained were averaged and from the means the tension and compression curves were drawn. These curves are assumed to be representative tensile and compressive strain relations for chilled wheel iron and are the curves upon which the stresses given are based.

In the case of the wheel under consideration it required a pressure of a little more than 96,000 lb. to mount it.

On the outer face of the wheel the maximum corresponding simple tensile stress due to mounting is 10,000 lb. per sq. in. and is in a tangential direction at the bore. As the distance from the bore increases the stresses in the tangential direction decrease up to the point where the inner and outer faces join beyond which a slight increase occurs. In the radial direction on the outer face the maximum compressive stress due to mounting corresponds to a simple stress of 11,600 lb. per sq. in. The variation in the magnitude of the stresses in the radial

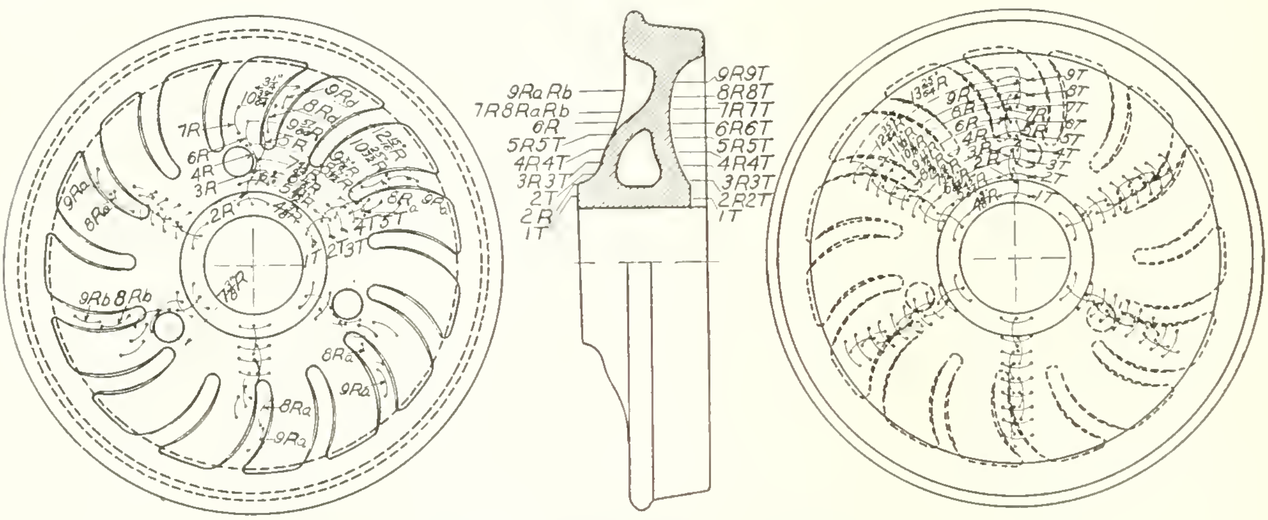


FIG. 2 LOCATION OF GAUGE LINES ON 33-INCH, 840 POUND ARCH PLATE WHEEL

static load a side thrust of 8,000 lb. or one-half of the estimated service flange pressure was added by means of the hydraulic jack and strain gage readings were taken again. The latter measurements thus represent the triple effect of mounting 25,450 lb. static load and 8,000 lb. flange pressure. With the static load equal to 25,450 lb. additional readings were taken with side thrusts of both 16,000 and 32,000 pounds, equal respectively to 50 per cent and 100 per cent of the estimated service flange pressure. It seems reasonable that the latter conditions of load do not differ materially from the normal maximum loading that might occur in service, and the strains in the wheel would therefore approximate those that would be present under the combinations of normal wheel fit, maximum static load and maximum flange pressure.

It is evident that the problem of the car wheel under load is one of compound stress; that is internal stress or force in more than one direction. In these tests the fundamental data are measured deformations or strains due to the effect of more than one stress acting within the material.

As no two specimens even when cut from the same wheel give identical stress-strain relations and as it would obviously be impracticable to cut a test specimen from each position in the wheel at which strains were measured, it was necessary in order to evaluate the "corresponding simple stresses" from the measured strains to deduce two curves which were assumed to be representative of chilled car wheel irons in tension and compression. For this purpose, thirteen specimens were tested in simple tension, and

direction clearly shows the presence of bending coupled with the direct thrust due to mounting.

The maximum tensile stress on the inner face due to mounting is likewise in a tangential direction at the bore and corresponds to a simple stress of 18,400 lb. per sq. in. The magnitude of the tensile stresses in the tangential direction decreases as the distance from the bore increases. The stresses in the radial direction on the inner face vary from 9,000 lbs. per sq. in. compression in the gage line nearest the bore to zero between gage lines 3R and 4R. The stress then becomes tension in 4R and the maximum tension 7,000 lb. per sq. in., in the radial gage lines is found in 5R beyond which the tension decreases and the stress again becomes compressive in 7R. This variation in stress in the radial lines also shows the presence of bending coupled with the direct thrust due to mounting.

After the addition of 13,050 lb. static load the tensile stresses on the outer face in the tangential gage lines 1T to 4T inclusive are not materially different from those caused by forcing the wheel on the axle. The effect of the added load is noted, however, by an increased tension in tangential gage lines 5T to 9T inclusive. In the radial direction the compressive stresses although different from those caused in mounting are relatively small. On the inner face the tensile stresses in the tangential gage lines 1T to 4T inclusive are somewhat smaller than those due to the wheel fit. In the radial direction the compressive stresses on the inner face are also of small value.

With the exception of gage lines 5T and 6T the stresses in the tangential direction in the outer face due to the dual effect of mounting and 25,450 lb. static load are not materially different from those caused by mounting. In 5T and 6T the static load increased the mounting stresses 5,200 and 4,600 lb. per sq. in. respectively. In the remaining tangential gage lines the change due to the added load was never in excess of 1,300 lb. per sq. in. In the radial direction the greatest change occurred in gage line 7R in which the compression was increased 3,800 lb. per sq. in. On the inner face no material change occurs in the tangential gage line due to the addition of the 25,450 lb. static load. The variation in the stress in the radial gage lines however, is considerably different from that of mounting. The most significant change is in radial gage line 5R, in which the tension of 7,000 lb. per sq. in. due to mounting was increased to 11,700 lb. per sq. in. by the addition of the 25,450 lb. load. This increase however, is not of serious import for two reasons; first, the static load is practically the maximum that the wheel should carry and second, the imposition of flange pressure decreases the tension until at 32,000 lb. flange pressure a compressive stress of 6,300 lb. per sq. in. exists in that gage line.

The triple effect of the wheel fit, 25,450 lb. static load and 32,000 lb. flange pressure on the outer face produces tension in all gage lines both radial and tangential except 2R, 3R and 9T. The significant fact is that the combination of stress producing factors results in tension in the radial direction in the region from 4R to 9R. Some later tests show that prolonged brake application in the arch face type of wheel also produces tension in the radial direction and further that the maximum tensile stress through brake application may be expected in the region 4R to 6R or near the junction of inner and outer plates. Taken separately the stresses here given are not dangerous. If, however, to these stresses the effect of a severe and prolonged brake shoe application is added the stresses might become of such magnitude as would cause incipient cracks leading to wheel failure. On the inner face the above mentioned combination of stress producing factors shows the stresses in a tangential direction to be practically equal to those due to mounting. There is a difference, however, in the distribution of the stresses in the radial direction. In mounting, the stresses, in 4R, 5R and 6R were tensile, but these are changed to compression by the addition of static load and flange pressure. The compressive stresses as found in the radial gage lines in the inner face are relatively unimportant. The addition of either the 8,000 lb. or 16,000 lb. flange pressure to the 25,450 lb. static load produces an intermediate effect between that of the static load alone and the combination of static load with 32,000 lb. flange pressure

The conclusions reached from this series of tests are that the stresses as found for the various load conditions are relatively unimportant. The maximum corresponding simple tensile stress (18,400 lb. per sq. in.) was due to the wheel fit and was found in the gage lines nearest the hub on the inner face. The addition of static load and flange pressure did not materially effect this value. As explained in the previous bulletin on wheel fit, and static load strains, stresses of high magnitude may be present in the hub regions and still be less dangerous than stresses of lesser value at other positions in the wheel. This is due to the fact that the stress in the hub region is a steady one, that is the material is not subjected to the dangers of repeated stress. The combined effects of normal fit, maximum static load and a flange pressure which is probably in excess of that received in normal wheel service produces tension (with a few minor exceptions) in both a radial and tangential direction on the outer face of the 840 lb. arch face wheel. On the inner face over the region investigated this combination of load results in tension in the tangential and compression in the radial gage lines. The tensile stresses on the outer face near the junction of the inner and outer plates resulting from the maximum static load and flange pressure are subject to repetition and at some points subject to complete reversal. The number of times, however, that a wheel, in its several years of life would traverse curves of small enough radii or at speeds high enough to produce 32,000 lb. flange pressure, is relatively small when compared with the millions of repetitions dealt with in the subject of repeated stress. Hence the question of severity of stress due to the triple effect of mounting, static load and flange pressure may be considered from the static viewpoint alone. It does not appear that the stresses due to these three effects are severe in themselves but these stresses if added to by abuse of the wheel through prolonged brake application might become large enough to cause incipient cracks leading to wheel failure.

Summary

The results of the tests made on the 33-inch-840-lb. arch face wheel to determine the combined effects of wheel fit static load and flange pressure show that,

a. In mounting the wheel on the axle the largest tensile strains in the wheel occurred on the inner face in a tangential direction at the bore and their magnitude decreased as the radius increased. The radial strains on the inner face are a maximum in compression at the bore, then as the radius increases the compression decreases to zero and then changes to tension at about the mean radius of the core, the tension reaching a maximum just before the inner and outer plates intersect beyond which the tension decreases, passes through zero and the strain again becomes compressive. The distribution of the strains plainly suggest bending due to the curvature in the section of the core region.

b. On the outer face of this wheel the strains in a tangential direction are a maximum in tension at the bore, as the radius increases the tension decreases up to a point near the intersection of the inner and outer plates beyond which a slight increase in tension occurs. In the radial direction over the region investigated the compression found near the bore becomes larger as the radius increases and reaches its maximum compressive value slightly beyond the mean radius of the core beyond which it rapidly decreases to practically zero. The strain distribution in the radial direction also plainly indicates a bending action coupled with the direct thrust due to mounting.

c. The largest tensile strains in the wheel caused by mounting the wheel on the axle are found in the hub-metal near the axle. Although apparently of large magnitude when expressed as "corresponding simple stress" these are steady strains, that is the metal is not subject to fluctuating or repeated internal stresses that would produce an alternate strain and removal or reversal of strain in the material. The character of the strains together with the backing provided the metal which is most highly strained probably allows the use, without injury to the material, of greater strains than could be normally used in metal subjected to simple tension or compression.

d. The normal static load of service when applied to the wheel does not materially alter the strains on the outer face of the wheel already present through mounting. On the inner face the bending of the curved plate in the core region becomes more pronounced as indicated by tensile strains in a radial direction. The tension thus shown is of less value than that due to mounting which is found in the tangential direction near the axle. If this type of wheel were called upon to carry excessively heavy static loads the tension then found might become significant, but for

normal service the tensile strains are not in themselves serious and they are modified and reduced by the application of flange pressure.

e. The triple effect of normal wheel fit, static load and flange pressure approximating the maximum service, in general, results in tensile strains in both radial and tangential directions on the outer face. The maximum tension occurs near the junction of the inner and outer faces and is in a radial direction. The tension as produced throughout the outer face by flange pressure although subject to some repetition may safely be considered as tension in the steady state for the number of times during the life of a wheel that it would traverse curves of small radii and at speeds high enough to produce 32,000 pounds flange pressure would be relatively insignificant when compared with the millions of repetitions dealt with in the subject of repeated stress. In themselves the combined strain effects are not of serious import. If to the strains caused by normal wheel fit, maximum static load and maximum flange pressure be added those strains caused by severe and excessively prolonged brake application the combined strain might then become large enough to cause incipient cracks leading to failure. On the inner face over the region investigated the strains in the tangential direction due to the combined effects of normal wheel fit, maximum static load and flange pressure are but little different from those of mounting. In the radial direction the strains are all compressive. The strains on the inner face in both radial and tangential directions are of relatively little importance.

That section of the report that deals with the strength of flanges will be published in our next issue.

New Jib Crane for Shapers

For the convenience of railroad shops, steel mills and other industries where the usual line of heavy work prevails, Gould and Eberhardt, Newark, N. J., have brought out for their shaping machines a simple but substantial jib crane to facilitate the easy manipulation of heavy pieces. This eliminates the use of awkward, costly and less productive overhead cranes. The crane itself, as shown in the illustration, is attached to the shaper in the most efficient location, being opposite to the operating side of machine. The machine being of direct drive makes it possible to revolve the crane completely around and handle all work within its range.

The design and capacity of the crane is such that it is self-supporting and will handle the maximum weight of work that the machine is capable of doing. It also has the following features:

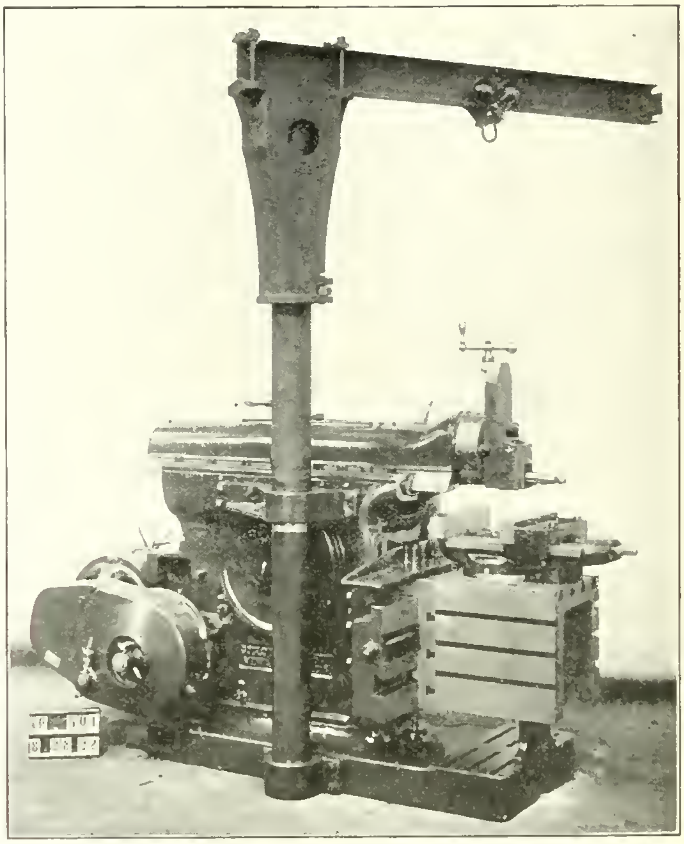
(a) Boom is of single I beam, insuring the required strength to safely provide for a load of 1,000 pounds at extreme end of same.

(b) Mast is of heavy wrought steel pipe securely clamped against the frame at two positions, thus distributing the load to the shaper frame more equally.

(c) The upper pintle is of cast steel rigidly held in a cap attached to the mast and having the ball and socket type bearing, which ensures proper alignment of the boom at all times, thus making it possible to revolve the crane with a slight pressure.

The machine as shown is of the most modern design, being both powerful and compact, having all levers within easy reach of operating position. The new start and stop lever is now arranged in a very convenient location and permits the operator to start or stop machine while remaining close to the work being done.

All machines are equipped with a single pulley drive and selective type gear boxes, which have all heat treated steel gears that run in heavy oil. By means of the patented double train gear drive, combined with the selective type gear drive, 8 changes of speed for every stroke ranging from 9 to 115 strokes per minute are possible. This feature itself makes this shaper very adaptable to manufacturing purposes where a variety of work is done.



NEW JIB CRANE FOR SHAPERS

Northern Pacific's New Equipment

The Northern Pacific Railway has announced equipment purchases totalling nearly $17,000,000, deliveries of which will be made largely in 1923. Included are 5,820 freight and express cars and 49 locomotives, as follows:

Three thousand 40-foot box cars with a capacity of 80,000 lbs., 1,000 freight refrigerator cars, 70 express refrigerator cars, 250 Hart convertible cars of 100,000 lbs. capacity, 250 steel gondolas of 100,000 lbs. capacity, 1,000 50-foot automobile and lumber box cars of 100,000 lbs. capacity, and 250 40-foot stock cars. The locomotive purchases include 20 Pacific type engines, 25 Mikado and 4 Mallets.

The Pacific type locomotives are intended for heavy passenger service and will weigh 509,700 lbs. Three will be equipped with the locomotive booster.

The Mikado type locomotives will weigh 540,000 lbs., and eight of them will be equipped with feed water heaters.

The Mallets will be used in heavy mountain freight service and will weight 740,100 lbs.

The Northern Pacific has also prepared plans for extensive shop improvements, as well as track and other facilities.

This carrier will build a new concrete and steel bridge across Central avenue, Minneapolis, Minn.

Snap Shots—By the Wanderer

The heating and ventilation of Pullman cars has probably been the cause of more comment, and much of it adverse than any other item in the whole wide range of railroad operation. Why are some cars cold and others hot is a query that seems almost as impossible of being answered as did the one of the cat, "Why do people kiss each other?"

I have noticed as I have journeyed to and fro on two roads that parallel each other for some two hundred miles, that, on one, the parlor cars are always comfortable, and on the other they sometimes are and sometimes they are not. The reason appears to lie in the method of using the steam. And, by the way, the cars on the delinquent road are more apt to be comfortable in cold weather than when the temperature is moderate.

It ought to be well known to railroad officers that the forward end of a car is always cooler or tends to be cooler than the rear. Also the construction of the Pullman car is known. There is a drawing room or toilet or both at each end and a passageway leading along the side thereof from the main body of the car to the door, and this passage is always on the right hand side as one goes to the door.

The heating pipes are arranged along the sides of the car and the valves are so adjusted that steam can be partially or wholly turned into one or both sides.

Then there is one item that is at fault. The thermometer by which the porter regulates the heat of the car is usually at the entrance to the passage at one end. If that end leads, the car is apt to be warm. If it follows there is likely to be a chilliness. I believe that one of the most successful car heating companies and one which, I think, has the Pullman Company, for a customer, advocates placing the thermometer in the center of the car. Why not follow its suggestions.

Under ordinary conditions of moderate temperature if the porter uses only one of the side lines of pipes for heating and should open that on the left hand side, the car will be chilly and seem drafty whether it really is or not; because there will be the long unheated passage that is constantly being replenished with cold air from without and is discharging it into the body of the car, along the floor on the side remote from the steam pipes. Naturally the car is uncomfortable.

On the other hand if the right hand pipes are used, the forward passage is warmed, the pipes in it are more than capable of caring for its limited volume; the flow of cold air is from the body of the car to the passage and the car will be comfortable. All of which in its simplicity is recommended to the attention of the powers that be.

Of course this won't provide for the careless leaving of the doors open during the whole period of a long station stop. But that is another matter, against the inanity and wickedness of which I have protested aforetime.

It would furnish a nice tidy little personal income that of the per diem car charges which railroads pay, that is some railroads, and which the layman would think could be avoided by a little of the "follow up." This is suggested by a rumor that is afloat, about a certain road that is rich in the outside property interests.

It is said, and I am quoting from a "they say," and not the result of a personal investigation; it is said, I say, that there is more apt to be a reported shortage of refrigerator cars than of any other type of equipment. And the aforesaid rumor is to the effect that this certain rich road had, in a period of refrigerator car shortage been reporting a stock of five cars at its main terminal.

It was not this alone but some other things that started an investigation, in which it was found that the figure five as to the stock of refrigerator cars was all right, but it should have had two noughts behind it. It also developed that the five with the two noughts had been there for thirty days. Yes, I really think that I could live in comparative comfort on $15,000.00 a month. Or I would even be generous enough to split fifty-fifty with the railroad company if they would give me the job of clearing out the yard. Almost any hustler with a few locomotives could do that. Yes, the art of following up would be a good one for some executives to cultivate.

Expert witnesses in court are usually paid good fees and when they appear for litigants with a weak case, they are frequently expected, though of course not directly asked, to skate along on what comes pretty close to being the ragged edge of perjury. I know that that is an ugly word and possibly an ugly statement but there does not seem to be any other that quite expresses my meaning.

Of course it goes without saying that the practical man, the man who has learned his subject from the hard knocks of every day experience, is much to be preferred as a witness even in weak cases, than the pure theorist who cannot have swept out all the dark corners into which experience penetrates.

It took me a long time to fathom the reason for the reluctance of railroad officials to permit their employes to appear on the witness stand. But I think I can see.

It is a characteristic trait of human nature, when employed in that way, to try and honestly succeed in seeing a subject in the light that is most favorable for its presentation in the interests of the client. Men will sincerely believe that they are telling the truth because they want that which they are saying to be the truth. It is only a variant from the old saying: "He has told that lie so often that he believes it himself."

The result may, however, be very embarrassing to an employing company when a servant goes astray in this way. The matter has been brought to my attention twice quite recently. One I believe I have already touched upon, when a master mechanic in order to sustain a position that he had taken before the court on his direct examination was driven by the cross-examination to say that the reports of engineers, as made out at the end of a run regarding their engines' performances, were unreliable and inaccurate because the men were tired and wanted to go home.

The second was that of a mechanical engineer of a great railroad who having assumed a similar position, was forced, on cross-examination, to stamp as unreliable, the reports made out by his fellow officials for the state.

Certainly these railroads would be in a perilous position if they were to be called upon to use these reports to support themselves in some position that they might take in a litigation or investigation. To have the testimony of one of their own staff put in against them to prove that their own documentary evidence was unreliable would be disconcerting, to say the least. And that is exactly the risk they run when their men are led into such positions.

Once in awhile the enthusiasm of witnesses goes so far, that their testimony amounts to a positive indictment of their employing railroads when their dismissal becomes necessary and they have to be placed upon the payroll of the people who employed them.

The trouble probably lies not only in the desire to be accommodating and a willingness to think that candle light and daylight are the same, but in a forgetfulness that there is such a thing as a cross-examination that follows like a Nemesis. If the testimony could only end with the direct all would be well.

If cases like those cited can be thrust into the experience of one isolated individual, what must the aggregate be? And it is this aggregate dumped into the experience of the railroad official, that leads him to keep his men at home and clear of the lure of the lawyer who is looking for expert testimony.

The Rhodes Tunnel Mask

People who travel de luxe in Pullman cars or even in the ordinary day coach have little, if any, realization af, the atmospheric conditions prevailing on locomotives during their passage through long tunnels, especially where the clearances are small. Under such conditions the temperature is apt to rise to 125 degrees Fahr. or more, and clothing as well as the air seems to be burning into the skin.

The air is so filled with the gases and smoke from the locomotive that breathing is difficult and may even be dangerous for one unaccustomed to it. The engine crews frequently manage by breathing through the nose, but the only safe method for a stranger is to bury the face in a bunch of waste and breathe slowly and carefully of the air that filters through. Even then the heat and

RHODES TUNNEL MASK

threatened suffocation seems almost unbearable, and it requires a great deal of will power to refrain from removing the waste from the face for a full breath of air. This, however, is a very dangerous thing to do, and has rendered more than one novice unconscious.

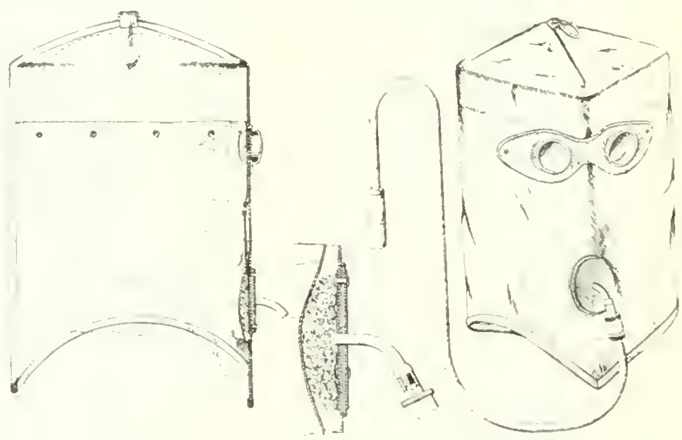
The Churchill method of ventilation makes for comparatively pure air in tunnels that would otherwise be nearly unbearable.

In the November, 1920, issue of Railway and Locomotive Engineering, there was an article descriptive of the smoke ducts and fan ventilators used on the Cincinnati, New Orleans and Texas division of the Southern Railway. The ducts were simply long pipes reaching from the smokestack to the back end of the tender, by which the smoke and gasses were exhausted back of the cab, and the ventilators consisted of fans drawing in air from close to the rails and delivering it into the cab.

The device illustrated in this connection is one, intended for the same primary purpose of delivering fresh air to the occupants of a cab while traversing hot and gas-filled tunnels.

It consists of a closely-woven canvas hood, provided with goggles through which the wearer can see. The lower portion of the hood or mask is made double with the edges at the bottom so stitched together that there can be no leakage of air between them. The outer casing has an opening to which a small rubber hose is attached which leads to a pipe coming from the main air reservoir on the engine. Opposite this opening it is well to have some filtering material, though this is not necessary. Near the top of the double portion of the mask there are a number of holes opening into the interior.

When the mask is in use it is simply slipped on over the head with the goggles in front of the eyes. A stream of compressed air, from the main reservoir, is then admitted to the space between the double portion of the mask. This air slightly expands the mask making it fit closely to the head, and the air, escaping into the interior,



DETAILS OF RHODES TUNNEL MASK

flows down over the face, past the nose and mouth and out at the bottom.

The expansion of the air cools it slightly and the outflowing stream prevents the entrance of the hot gas-laden air of the cab to the interior of the mask. The wearer is thus provided with an ample supply of cool fresh air so long as the mask is on and the valve from the main reservoir open.

This mask is an exceedingly efficient device and only requires a place on the engine to which to attach the rubber tubing. It is quickly applied, it being only necessary to slip it down over the head and open the air valve. In tunnels where suffocation would seem to be almost inevitable, without protection, this mask makes the trip perfectly comfortable so far as breathing is concerned. It is being manufactured by the R. G. S. Manufacturing Co., of Danville, Ky.

Chinese Railroad Purchases American Trains

The Tientsin-Pukow Railway has purchased five complete American railroad trains, consisting of five mail coaches, five baggage coaches, five dining cars, five parlor cars, 30 sleeping cars, and three private cars. The locomotives now in operation on the road are also of American manufacture.

The Tientsin-Pukow Railway is the most important north-and-south trunk line in China. By connecting at Nanking with the Shanghai-Nanking line and at Tientsin with the Peking-Mukden Railway, it comprises the main link between the rich and populous lower Yangtse Valley and Tientsin, the metropolis of the north, and Peking, the capital. Practically all tourist travel passes over this line.

Notes on Domestic Railroads

Locomotives

The New York Central has ordered ten Mikado type locomotives from the Lima Locomotive Works, and ten of the Mikado type from the American Locomotive Company.

The New York, Ontario & Western has placed an order with the American Locomotive Co. for six locomotives of the Mountain type.

The Chicago Junction has purchased five eight-wheel switching locomotives from the Lima Locomotive Works.

The Quebec Development Co. has order from the American Locomotive Co. 14 four-wheel tank engines.

The Buffalo, Rochester & Pittsburgh has ordered five Pacific type locomotives, nine switching locomotives, 16 Mallet type locomotives from the American Locomotive Company.

The Chicago, Rock Island & Pacific has ordered 30 Mikado type and ten Mountain type locomotives from the American Locomotive Company.

The Central of New Jersey has ordered ten Mikado type locomotives from the American Locomotive Company.

The Norfolk Southern has ordered four consolidation type locomotives from the Baldwin Locomotive Works.

The Southern has ordered 50 Mikado type locomotives and 16 Pacific type locomotives from the American Locomotive Company.

The Great Northern has ordered 30 Mountain type locomotives and 28 2-10-2 type locomotives from the Baldwin Locomotive Works.

The New York, Chicago & St. Louis has ordered six Pacific type locomotives from the American Locomotive Company and 30 Mikado type locomotives from the Lima Locomotive Works.

The Canadian Pacific has ordered 16 Pacific type locomotives from the American Locomotive Company.

The Pennsylvania has placed an order with the Baldwin Locomotive Works for the construction of 275 locomotives for heavy freight service, delivery to be made before November.

The Boston & Albany is reported to have purchased eight freight locomotives.

The Seaboard Air Line has entered the market for about 30 locomotives of the Mikado type.

The Oliver Iron Mining Co. has ordered 12 eight-wheel switching locomotive from the American Locomotive Co.

The Western Maryland is said to be in the market for 20 locomotives of the consolidation type.

Cambria & Indiana has ordered two Consolidation type locomotives from the American Locomotive Company.

The Republic Iron & Steel Company has ordered five 0-8-0 type locomotives from the Baldwin Locomotive Works.

The Louisville & Nashville contemplates buying 50 locomotives in the near future.

The Denver & Rio Grande Western has ordered 15 Mallet type, ten Mountain type and 20 Mikado type locomotives from the American Locomotive Company.

The Elgin, Joliet & Eastern is inquiring for 15 Mikado type locomotives.

The Elgin, Joliet & Eastern has ordered ten Mikado type locomotives from the American Locomotive Company.

The Philadelphia & Reading has ordered 25 Consolidation type locomotives from the Baldwin Locomotive Works.

Freight Cars

The Illinois Central has ordered 1,000 automobile cars from the American Car & Foundry Company, 500 automobile cars from the Western Steel Car & Foundry Company, and 500 automobile furniture cars from the Mt. Vernon Car Manufacturing Company.

Derby Oil Company ordered 25 tank cars from Standard Tank Car Company.

Canadian Pacific ordered 300 flat cars from Eastern Car Company, 300 gondola cars from Canadian Car & Foundry Company, and will build 50 tank cars in their own shops.

The New York Central has under consideration the question of purchasing a large number of freight cars.

The Bethlehem Steel Company is inquiring for 30 hot metal cars of 50 tons' capacity.

The Chicago, North Shore & Milwaukee has ordered 20 general service cars from the Standard Steel Car Company, and 15 50-ton gondola cars from the General American Car Company.

Tidewater Oil Company inquiring for 125 tank cars of 10,000 gallons' capacity.

New York, Chicago & St. Louis ordered 1,000 composite hopper cars from the Pressed Steel Car Company, and 500 composite gondola cars from the Standard Steel Car Company.

Fruit Growers Express inquiring for 1,000 steel underframes for refrigerator cars.

The Louisville & Nashville contemplates buying about 6,000 freight cars.

The Muscle Shoals, Birmingham and Pensacola is in the market for some freight cars.

The Carolina, Clinchfield & Ohio has ordered underframes and superstructures for ten caboose cars from the Virginia Bridge & Iron Company.

The Chicago & Illinois Midland is reported to be inquiring for 500 gondola car bodies.

The Gulf Refining Company has ordered 150 tank cars from the Standard Steel Car Company.

The Duluth, Missabe & Northern is inquiring for 100 box cars of 40 tons' capacity.

The Northern Pacific has issued inquiries for 1,500 refrigerator underframes.

The General Petroleum Corp has placed an order with the Pennsylvania Tank Car Co. for 21 insulated tank cars.

The St. Louis-San Francisco is reported to be in the market for 500 gondola bodies.

The Hillman Coal & Coke Company has ordered 300 hopper cars of 70 tons' capacity from the Pressed Steel Car Company.

The Buffalo & Susquehanna has ordered 200 all-steel hopper car bodies of 55 tons' capacity from the Buffalo Steel Car Company.

The New Jersey, Indiana & Illinois has ordered 150 single sheathed steel-frame automobile cars from the American Car & Foundry Company.

The Interstate Railroad has ordered 500 hopper cars of 55 tons' capacity from the Pressed Steel Car Company.

The Philadelphia & Reading is reported to be contemplating the purchase of 2,000 freight cars.

The Central of New Jersey is having 200 box cars repaired at the shops of the Standard Steel Car Company.

The Louisiana Railway & Navigation Company is inquiring for 300 40-ton steel underframe box cars.

The Bingham & Garfield is inquiring for 100 80-ton ore cars.

The Seaboard Air Line is inquiring for 1,000 40-ton steel underframe ventilated box cars and 1,000 50-ton steel underframe gondola cars.

The Texas Company is inquiring for 300 tank cars.

The Michigan Central is inquiring for 100 steel gondola cars of 50 tons' capacity.

The Elgin, Joliet & Eastern Ry. has ordered 200 gondola cars from the Pullman Co., 100 gondolas and 100 hopper cars from the Mt. Vernon Car & Manufacturing Co., and 100 hopper cars and 100 gondolas from the Pressed Steel Car Co.

The Great Northern has ordered 125 tank cars from the Chicago Steel Car Co.

The Southern has entered the market for 1,000 50-ton hopper cars, 1,000 55-ton hopper cars, 2,000 40-ton box cars, 1,000 50-ton low side gondolas and 200 stock cars.

The Atchison, Topeka & Santa Fe is said to be inquiring for 50 tank cars.

The Delaware, Lackawanna & Western is inquiring for 300 double-sheathed automobile cars of 40 tons' capacity.

Utah Copper Company is inquiring for 50 ore cars of 80 tons' capacity.

Passenger Cars

The Chicago & Illinois Midland is inquiring for 50 miscellaneous passenger cars.

The Southern Pacific is inquiring for five 60-ft. coaches, sixty 72-ft. interurban cars, fifteen 72-ft coaches, five 60-ft. steel chair cars, seven 77-ft. dining cars, five 70-ft. steel baggage cars, ten 70-ft. baggage cars with automobile end doors and forty 70-ft. combination baggage and postal cars.

The Western Pacific has placed an order with the Pressed Steel Car Company for twenty baggage cars.

The Louisville & Nashville expects to enter the market for about 50 cars for passenger service.

The Southern Railway is inquiring for five dining cars.

The Long Island has ordered from the Westinghouse Electric & Manufacturing Company forty motor passenger cars, twenty trailers and four baggage and mail cars.

Buildings and Structures

The Great Northern is completing plans for a car repair shop at St. Cloud, Minn.

The Atchison, Topeka & Santa Fe is considering the construction of new roundhouses and car repair shops at Emporia, Kans.

The Union Pacific has plans under way for the construction of a new engine house and repair shops at Topeka, Kans.

The Southern Pacific contemplates the construction of additional shop facilities at Los Angeles, Calif., the cost of which will be about $1,000,000.

The Atchison, Topeka & Santa Fe will construct extensions to the shop facilities at San Bernardino, Calif., the cost of which will be about $1,250,000. The plans provide for the rearrangement of the machine, boiler and paint shops, and also for a 120-ft. turntable.

The Pere Marquette has awarded a contract to Battey & Kipp, Chicago, for the construction of a 30-stall enginehouse, a 100-ft. electrically operated turntable, a concrete coaling station and sandhouse, a water tank and other similar facilities. The total cost of the project will be over $1,000,000.

The Chesapeake & Ohio contemplates the expenditure of approximately $4,000,000 in the improvement of terminal facilities at Newport News, Va.

The Union Pacific has awarded a contract for the construction of water softeners to the Graver Corporation, East Chicago, Ind., to be located at Las Vegas, Nev.; Dry Lake, Nev.; Box, Nev., and Kelso, Calif.

Supply Trade Notes

The Westinghouse Air Brake Company has announced the appointment of **R. W. Williams** to the office of Southwestern District Manager for both the Westinghouse Air Brake Company and the Westinghouse Traction Brake Company, with headquarters at St. Louis. This is the position recently made vacant by the sudden death of R. E. Adreon, who, in addition to his duties as president of the American Brake Company, had held the title of acting Southwestern Manager since C. P. Cass left the St. Louis Office of the Air Brake Company several years ago to become president of the Westinghouse Pacific Coast Brake Company, at Emeryville, Cal. Coincident with the announcement of Mr. Williams' promotion in the Air Brake Company, the American Brake Company announced his election as vice president of that organization. Mr. Williams has been connected with the Westinghouse Air Brake Company since April 1, 1902, when he went to Wilmerding to accept the position of secretary to John F. Miller, now vice chairman of the Board of Directors.

R. W. WILLIAMS

Mr. Williams was born in Renovo, Pa., in 1878. His boyhood was spent in Williamsport, Pa., where he attended public school. He was graduated from high school with the class of 1897 and immediately entered the employ of the Pennsylvania Railroad, serving in the freight and maintenance of way departments at Williamsport until joining the Air Brake Company. After remaining in the general offices of the Air Brake Company at Wilmerding for seven years, he was transferred to the Southeastern district office in Pittsburgh. In 1910, he went to the Cincinnati office and two years later was appointed Representative and assigned to the Atlanta office. He returned to the Pittsburgh office in September, 1920, where he has served up to the present time. Mr. Williams is widely known in railway and traction circles and is actively identified with a number of clubs and associations, among which are included the American Electric Railway Association, the Central Electric Railway Association, and Air Brake Association, Railway Club of Pittsburgh, Pittsburgh Athletic Association and the Edgewood Country Club. Mr. Williams is married and has three children. Before going to St. Louis he resided in Wilkinsburg, Pa.

C. G. Carothers, formerly railroad representative with the B. F. Goodrich Rubber Company with headquarters at Akron, Ohio, has been appointed Service Engineer with **The Franklin Railway Supply Company, Inc.**, and will be in Cincinnati, Ohio. Mr. Carothers was born at Matton, Ill., and was educated in the grade and high schools of his native town. He served an apprenticeship as machinist at Matton on the Cleveland, Cincinnati, Chicago & St. Louis, and then worked for a number of western railroads. He subsequently attended Purdue University, Lafayette, Ind., and was graduated as a railway mechanical engineer in 1912. From August of that year to August, 1914 he was mechanical engineer with the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio. He then served to September, 1917 as senior mechanical engineer with the Interstate Commerce Commission, Division of Valuation, Southern District, with headquarters at Chattanooga, Tenn. In July, 1917, he received a commission as captain in the Engineers Reserve Corps and was called to active service the following September to attend the Second Engineer Officers' Training Camp, American University, Washington, D. C. He subsequently was attached to the 301st Engineers of the 76th Division at Camp Devens, Ayer, Mass., and in January, 1918, was sent to France to report to the general superintendent of motive power, Colonel H. H. Maxfield of the Railway Transportation Corps. He subsequently served in the railroad yard at Is-sur-Tille as master mechanic and built a shop there, also one at Villa-le-Sex, the advance section ammunition depot. He later served as superintendent of motive power of the 13th Grand Division, with headquarters at Is-sur-Tille.

A. F. Zinkan has joined the Inspection Department of **The Franklin Railway Supply Company, Inc.** Mr. Zinkan started as machinist apprentice with the Big Four at Brightwood Shops in November, 1900. After completing his apprenticeship, (January, 1912) he was placed on the Inspection Staff and assigned to the plants of the various locomotive builders in connection with the construction of new locomotives. He continued in this work until 1915, when he was made gang foreman at Beachgrove shop. In 1917 he was promoted to Chief Inspector in charge of the inspection of the new locomotives in various plants. At the time Mr. Zinkan resigned to enter the employment of the Franklin Company, he had completed 22 years of service with the New York Central Railroad.

Edwin L. Andrew has been appointed Assistant to Manager of the Department of Publicity of the **Westinghouse Electric & Manufacturing Company** at East Pittsburgh, Pa. Although studying engineering, Mr. Andrew became interested in advertising, through magazine and other advertising activities, in college and started on an apprenticeship course at East Pittsburgh with the intention of taking up advertising work when the course was completed. He has found that engineering has a distinct value in his advertising work and believes that advertising is a legitimate and attractive field for an engineer with commercial vision. Mr. Andrew was born in Washington county, Pennsylvania, and moved in 1907 to Tacoma, Washington, where he had preparatory schooling at the Stadium High School. He gradnated from the University of Wisconsin in 1916, after which he entered the employ of the Westinghouse Company at East Pittsburgh on the apprenticeship course. His rise since that time has been steady. He has served at the main works and also at the Cincinnati office of the Westinghouse Company. Mr. Andrew was in the army for more than a year, entering the service as a private and being promoted to a second liteutenantcy in a short time.

Mr. H. J. Titus, until recently with the American Locomotive Company, at Paterson, N. J., joined the **Franklin Railway Supply Company, Inc.**, New York, as Assistant Engineer in the Engineering Department on January 1, 1923. Mr. Titus was born on May 5, 1892, in Conneaut, Ohio. He is a graduate of the public and high schools of Schenectady, N. Y. From 1912 to 1915 he attended Columbia University, taking the Mechanical Engineering Course in the Schools of Mines, Engineering and Chemistry.

Mr. Titus's first employment was with the American Locomotive Company, Schenectady, spending a year in the machine shop and schedule department. From June, 1915, until November, 1916, Mr. Titus served as draftsman, designer and calculator with the Chicago, Milwaukee and St. Paul R. R. From the C. M. and St. P., Mr. Titus returned to the American

Locomotive Company at Paterson, N. J., as Assistant Maintenance Engineer in charge of the power plant and machine tools. In December, 1917, he enlisted in the Signal Corps for training as pilot in the Air Service, later receiving his commission as second lieutenant at Chaunte Field, Ill. Upon resigning his commission early in 1919, Mr. Titus resumed his position with the Amercian Locomotive Company at Paterson, N. J., remaining there until his resignation to join the Franklin Railway Supply Company, Inc.

Mr. George H. Zouck, until recently Mechanical Engineer with Mr. W. H. Marshall, entered the service of **The Franklin Railway Supply Company, Inc.**, as Assistant Engineer in the Engineering Department on January 1, 1923.

Mr. Zouck, born in Hanover, Pa., in 1888, is a graduate of Cascadilla Preparatory School, Ithaca, N. Y. ('07), and Cornell University ('11). From 1911 to 1914, Mr. Zouck was testing and erecting engineer with the York Manufacturing Company, his duties involving pipe work, steam engines of slide, Corliss and piston type, triplex pumps and steam driven duplex pumps for boiler feed and brine circulation. From 1914 to 1915 he was superintendent of Building and Paving Operations of the Consolidated Engineering Company of Baltimore, Md., his work consisting largely in concrete operations, involving the employment of from 100 to 200 men. From 1915 to 1916 he was engaged in the designing and engineering of overshot wheels and impulse wheels for I. X. L. Water Wheel Company, Hanover, Pa. He then joined the Oxwell Acetylene Company, Newark, N. J., remaining until 1918 as designing and developng engineer in connection with oxyacetylene welding and cutting apparatus, including special cutting and welding machinery. From 1918 until 1920 Mr. Zouck was engaged in the development and design of welding and cutting appliances for the Air Reduction Company, N. Y. In 1920 Mr. Zouck went with Mr. W. H. Marshall as Mechanical Engineer his last connection prior to joining the Franklin Railway Supply Company, Inc.

F. E. Sheehan, formerly representative of the **Texas Company**, has been appointed assistant district manager of the Western district, with headquarters in the Arcade building, St. Louis, Mo.

C. S. Sale, formerly assistant to the president of the Railway Car Manufacturers' Association, has resigned to accept an appointment with the **American Car & Foundry Company, New York.**

Major J. L. Hays has been appointed commercial engineer of the **Safety Car Heating & Lighting Company**, with headquarters at the Philadelphia, Pa., office. Major Hays was formerly electrical engineer with the Stone-Franklin Company until January 1 of this year, when the car lighting interests of the Stone-Franklin Company were absorbed by the Safety Car Heating & Lighting Company.

S. G. Downs, general sales manager of the **Westinghouse Air Brake Company**, Wilmerding, Pa., has been elected vice-president in general charge of sales and commercial activities. Previous to his appointment as general sales manager, he has been president of the Westinghouse Pacific Coast Brake Company, and Western district manager of the Westinghouse Air Brake Company.

William G. Willcoxon, formerly with the Boss Nut Company has joined the sales department of the **Gold Car Heating & Lighting Company**, with headquarters at Chicago, Illinois.

Stephen F. Sullivan, sales manager of the **Ewald Iron Company**, has been elected vice-president of the company with headquarters at Chicago, Ill.

The Westinghouse Electric & Manufacturing Company have announced several changes in the branch offices of the company.

Two of the changes concern the managerships of two offices, the Baltimore and Huntington, W. Va., branch offices. C. V. Woodward has been appointed manager of the former office and F. C. Reed has been made manager of the Huntington office. R. J. Ross has been appointed assistant manager of the Transportation Division of the Philadelphia office and W. F. James has been appointed manager of the Industrial Division of the Philadelphia Office, succeeding R. F. Moon, who has resigned to accept the vice presidency of the Atlantic Elevator Company, of New York.

C. G. Shafer is now a Service Engineer in **The Franklin Railway Supply Company, Inc.**, with headquarters at Memphis, Tenn. Mr. Shafer's first railroad employment was as a machinist apprentice on the Lehigh New England Railroad, Pen Argyl, Pa. He entered the employ of the railroad in June, 1899, and resigned in July, 1902, to become locomotive fireman on the New York, Ontario and Western, at Middletown, N. Y. Mr. Shafer continued as locomotive fireman with the N. Y. & O. until 1910, when he was promoted to locomotive engineer. In August, 1917, Mr. Shafer secured a leave of absence and accepted a position as locomotive engineer with the Southern Railway at Knoxville, Tenn. On November 26th, 1917, Mr. Shafer was appointed Road Foreman of Engines on the Appalachia Division of this road with headquarters at Bristol, Va. On February 15, 1920, Mr. Shafer became Road Foreman of Engines of the Knoxville Division, Southern Railway, with headquarters at Knoxville. He seld this position until December 31, 1922, when he resigned to become Service Engineer with The Franklin Railway Supply Company, Inc.

Broderick Haskell, Jr., has joined the Service Staff of **The Franklin Railway Supply Company, Inc.**, as Special Engineer. Mr. Haskell, who is a graduate of the Massachusetts Institute of Technology, has been connected with several engineering organizations. In his new connection Mr. Haskell will be engaged on special work in connection with the Locomotive Booster.

W. M. Holton joined **The Franklin Railway Supply Company, Inc.** as Service Engineer on January 1, 1923. Mr. Holton began his railroad career as a fireman in yard service on the Michigan Cenral R. R. in 1900. He was promoted to road service in 1901 and fired freight and passenger locomotives until the fall of 1905, when he was made engineer. In November, 1917, he was advanced to Road Foreman of Engines, which position he held until he resigned to join the Franklin service staff.

C. C. Clabaugh is now Inspector with the **Franklin Railway Supply Company, Inc.**, stationed at the plant of the Lima Locomotive Works, Lima, Ohio. After completing his apprenticeship in Washington, D. C., Mr. Clabaugh entered the employ of the New York Central as a machinist, in April, 1907. He was subsequently promoted to piece work inspector and served in various capacities at the Collinwood, Ohio, shops. At the time of Mr. Clabaugh's resignation to join the Franklin Railway Supply Company he was gang foreman.

Items of Personal Interest

E. A. Rauschart, master mechanic of the Montour Railroad has been appointed mechanical superintendent at Coraopolis, Pa.

L. J. Gallagher has been appointed road foreman of engines of the Northern Pacific with headquarters at Missoula, Mont. Mr. Gallagher entered the employ of the Northern Pacific as a locomotive engineer in 1902, and has served as an engineman and road foreman on the Rocky Mountain division since that date.

J. E. Davenport has been appointed superintendent of fuel and locomotive performance of the New York Central, with headquarters at Utica, N. Y., succeeding Robert Collett, resigned.

John A. Marshall, road foreman of engines at Duluth, has been appointed master mechanic of the Lake Superior division of the Northern Pacific, with headquarters at Duluth, Minn.

George T. Strong has been appointed master mechanic of the Virginian at Princeton, W. Va., succeeding G. H. Lanton, resigned.

J. Butler, formerly master mechanic of the Ann Arbor at Owosso, Mich., has been promoted, and is now superintendent of motive power, with headquarters at the same point.

E. Becker, master mechanic of the Chicago & North Western, with headquarters at Escanaba, Mich., has been appointed master mechanic of the Green Bay and Western, with headquarters at Green Bay, Wis., succeeding T. J. McPherson, resigned.

G. C. Goff has been appointed master mechanic of the Southern with headquarters at Spencer, N. C., succeeding **B. McBride** who has been transferred in a similar capacity at Charleston, S. C.

E. P. Kelly has been appointed general enginehouse foreman of the Boston & Albany at West Springfield, Mass., succeeding A. L. Babcock, retired.

J. S. Jones has been appointed master mechanic of the Chicago & North Western at Antigo, Wis., succeeding E. Holmquist.

W. J. Kirsch, master mechanic of the Central division of the Union Pacific with headquarters at Maryville, Kans., has been transferred to the Kansas division with headquarters at Kansas City, Kans. **H. L. Ellerbush** succeeds Mr. Kirsch as masted mechanic at Maryville, Kans.

M. J. Powers has been made master mechanic of the Union Pacific at Pocatello, Idaho, succeeding **J. M. Gilfoyle,** who has been appointed master mechanic of the Utah division with headquarters at Pocatello, Idaho.

C. Peterson has been appointed master mechanic of the Denver & Salt Lake, with headquarters at Denver, Col.

J. H. Judd has been appointed roundhouse foreman of the Chicago & North Western at Waseca, Minn., succeeding **E. A. Strike** who has been appointed road foreman of engines at Green Bay, Wis.

H. H. Thurber has been appointed general foreman of the Chicago & North Western at Huron, S. D., succeeding O. N. Protz, promoted.

C. C. Densen has been appointed roundhouse foreman of the Union Pacific at Hugo, Colo., succeeding **C. C. Bogue,** who has been appointed district foreman at Ellis, Kans.

Books, Catalogues, Etc.

A. R. A. Bulletin for 1922—The American Railway Association has prepared an annual bulletin for 1922, the purposes of which, as described in the foreword, are:

"This bulletin is issued as a statistical digest of related economic and transportation factors applied to the movement of the country's production during the year 1922 and prior years. A careful analysis of the trend of transportation factors, production, prices and shipments has been made to serve as a background of business and railroad conditions subsequent to the war period, and to give individual railroads and shippers a competent guide, statistical reference and index to industrial and agricultural activity, together with the performance of railway transportation during 1922."

Copies may be obtained by addressing the Car Service Division of the American Railway Association, Washington, D. C.

The Pensylvania News, a newspaper by, and for, the employees of the Pennsylvania Railroad, in the Eastern Region, has made its initial appearance. The editor is Walton M. Wentz, formerly of the Railroad Company's Publicity Bureau, and the assistant editor, C. William Duncan, until recently a member of the local staff of the Philadelphia *Evening Public Ledger. The Pennsylvania News* will be issued from Broad Street Station, and starts its career with a circulation of 116,661. It will go, free, to every worker on the Railroad's Eastern Region lines, and in the General Offices at Philadelphia. It will be published on the 1st and 15th of each month, and consists of eight pages, five columns wide, and approximately half the size of the city dailies. The purpose and object of the new paper are explained in the leading editorial, which states:

"It will be the product of home talent and will consist largely of items of news concerning the employees of the Eastern Region, their families, and what they are doing. Its aim will be to enlighten as well as to entertain.

The Pensylvania News will stand for just what its name signifies—news; railroad news about the Pennsylvania Railroad. It expects to get personal about the Eastern Region, to get all of the employes better acquainted with one another, and with the property entrusted to their cars. It is placed in the hands of the employes, confident that they will all coöperate in making it a worth-while publication, with just the influence in the big Pennsylvania Railroad family that they want it to have."

The Pennsylvania News for the Eastern Region is the third paper of its character to be established on the Pennsylvania Railroad, similar publications having been inaugurated, within the last fourteen months, at Pittsburgh for the Central Region, and Chicago for the Northwestern Region. The three publications will have a combined circulation of well over 200,000. The Eastern Region, which the new paper will cover consists generally of the lines of the Pennsylvania Railroad east of Altoona and Renovo, Pa.

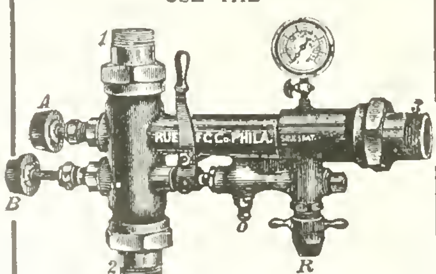
Specifications and Tests of Petroleum Products. Federal Specifications and testing methods covering various petroleum products are given in Technical Paper 323, just issued by the United States Bureau of Mines. The specifications cover motor gasoline, aviation gasoline, naphtha, kerosene, lighthouse kerosene, signal oil, fuel oils, fuel oil for Diesel engines, bunker fuel oil, and lubricants. Under the general heading of lubricants, special specifications are given for aircraft machine gun oil, car and locomotive oil, cup grease, Diesel engine lubricating oil, floor oil, gun and ice-making oil, paraffin wax, electric switch oil, rust-preventing compounds, etc.

The testing methods outlined include color tests, cloud and pour tests, determination of viscosity, melting points, flash points, water and sediment, sulphur, etc.

The specifications given were recommended by the Interdepartmental Petroleum Specifications Committee, of which N. A. C. Smith, petroleum chemist of the Bureau of Mines, is chairman, and have been officially adopted by the Federal Specifications Board for the use of the departments and independent establishments of the Government in the purchase of materials covered by them. The Interdepartmental Petroleum Specifications Committee was assisted in the preparation of the specifications by an advisory board consisting of representatives of several engineering and technical societies.

Technical Paper 323 may be obtained from the Superintendent of Documents, Washington, D. C., at the price of 10 cents.

The Elvin Mechanical Stoker Company has recently issued a Service Hand Book and Shop Manual. The booklet is of pocket size, contains 130 pages, and describes the various parts of the Elvin Mechanical Stoker, and also gives instruction in regard to the operation, inspection and maintenance. It is illustrated with a series of plates, and gives the numbers and names of all parts of the stoker. Copies may be obtained from the company, address 50 Church Street, New York.



Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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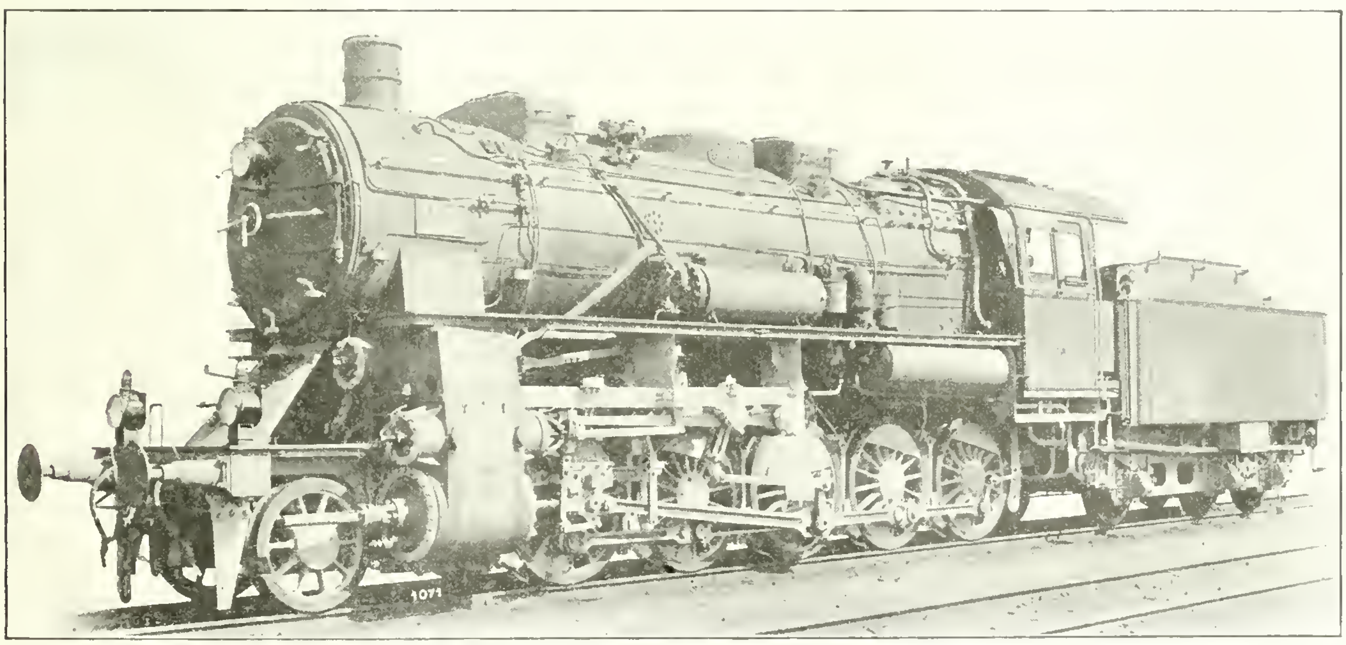
The German Standard 2-10-0 Type Three Cylinder Locomotive

Standard Freight Engine is Equipped With Schmidt Superheater and Feed Water Preheater

By Desider Ledacs Kiss, M. E., Budapest

Local patriotism and the mutual jealousies of the individual states that comprised the German Empire were so strong that locomotives and other railway materials were built by firms in and for service in the respective states. Thus, locomotives for the same class of work were built along quite different lines, and those on the Saxon State Railways, for example, can be distinguished at first glance from those in use in Prussia, Bavaria, or the other German states, and vice-versa. The disadvantages of a situation of this kind were keenly felt soon after the beginning of the world war, and on a resolution of the Central Railway Board it was decided that locomotives of the greater units of the railways of each state be built to a common standard or design, permitting only insignificant differences between locomotives of the different states. In this way, what is known as the German "consolidation" locomotive was developed.



2-10-0 Type, Standard "Consolidation" Type Three-Cylinder Locomotive of the German State Railways for Freight Service, Equipped With Superheater, and Feed Water Pre-Heater and Purifier. (Built by Hannoversche Maschinenban A. G.)

This superheater locomotive has three cylinders of equal diameter, such as have been used in England with good success.

Many advantages are claimed for three-cylinder locomotives using superheated steam over four-cylinder balanced engines, such as the de Glehn, von Borries, etc., in that it is simpler, lighter, and runs almost as smoothly as the four-cylinder locomotive, and the employment of superheated steam gives good boiler efficiency. Several European railways have transformed their four-cylinder engines, or built new engines of the three-cylinder design.

The simple three-cylinder locomotive has many advantages over the two-cylinder locomotive, because the starting difficulties which always exist in two-cylinder engines do not appear there. Further, the engine performs 50 per cent more work than the two-cylinder locomotive, and finally, at high speed, the three-cylinder locomotive runs more smoothly. On the contrary, the three-cylinder locomotive has the disadvantage of being heavier and more expensive, though but slightly, because the inside cylinder serves as a smokebox support and frame stiffener, saddle cylinder castings being seldom employed in Europe. The American three-cylinder locomotive would not have this disadvantage in comparison to their two-cylinder locomotives, because saddle cylinder locomotives are generally used there. Further, the employment of the crank axle labors under slight disadvantage as compared with the two-cylinder engine, but this is unimportant, because the arrangement of the cylinders is such that two cylinders are placed outside and one inside the frames, so that the cranks form exactly, or nearly an angle of 120 degrees with one another. Thus, the form of the crank axle is very simple, it manufactures lighter and much less expensive than that of the four-cylinder balanced engine, which many railways ceased to employ owing to the difficulty of fabricating the crank axle.

On this 2-10-0 type locomotives, the driving axle is the middle coupled axle.

The outside cylinders are placed hoizontally, and the inside cylinder is inclined in the proportion of 1.5789 because the two forward coupled axles obstruct the way of its connecting rod. The piston valves are located above the outside cylinders, while the valve of the inside cylinder is to the side on account of the smokebox. Each cylinder forms a separate casting. The inside cylinder serves as a smokebox support and frame stiffener. Its axis is 4 in., from the locomotive centre.

The Walschaerts valve gear directs inside admission piston valves: the cut-off can be varied from 10 to 80 per cent, equally in the forward or backward movement. The inside valve stem is actuated by the two outside valve gears. The crosshead guide has one bar.

The main frame consists of 4 in. bars, which are constructed of steel plate.

The springs of the three forward axles are located over the axleboxes and interconnected with equalizing beams. Between the running and first coupled axle is located an equalizing beam supported longitudinally and in the cross direction. Between the last two axles, common bearings springs are placed on both sides with two helical springs at their end. It seems that this heavy locomotive, which weighs 90 tons in working order, it was necessary to provide the trucks with stronger springs in order that they would not damage the line to a greater extent than the former engines.

The Spring arrangement referred to was worked out after long study, tests and experiments in order to devise a suitable method of distributing weight most favorable to track and superstructure.

To enable the locomotives to pass easily around curves they are provided with Bissel running axles and have 3/16 in. rail clearance. The second and fifth coupled axles have 3/4 in., lateral displacement, and the flange of the driving wheels are turned 19/32 in. smaller. Thus, the locomotives have 16 ft. 5 in. rigid wheelbase.

The Belpaire firebox boiler is set over the frames and is above the last two coupled driving axles. The middle section of the forward grate can be dumped and is set with a screw.

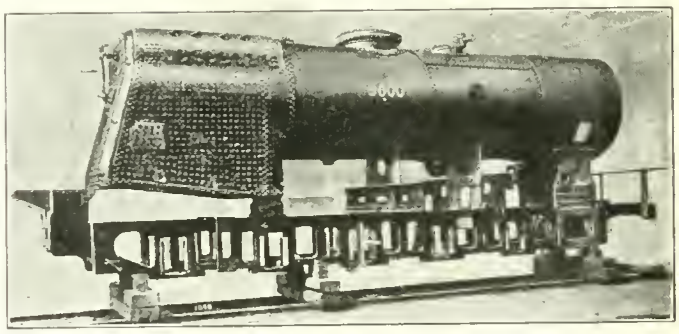
The ashpan is fitted with two air openings at the front and one at the back that can be opened or closed from the cab. The bottom openings can also be adjusted from the same place.

The boiler barrel is made of two rings having a thickness of 3/4 in., with a mean diameter of 3 ft. 2 13/16 in. The boiler center is 9 ft. 10 in., above the top of the rail. The boiler contains 195 tubes 1 5/8 in. in diameter and 15 ft. 19 in. long, and 34 flues 4 7/32 in. in diameter are used for the superheater. These are arranged in four rows. The dome is placed on the second ring and contains the Schmidt and Wagner throttle valve.

As in every new locomotive of the Prussian State Railways, this one is equipped with the Knorr exhaust steam feed water pre-heater. The water pump for the feed water preheater has a capacity of 556 gallons per minute, and is placed on the left side of the engine.

The brakes are applied to one side of all coupled wheels; the Knorr one-chamber air brake, which is used can develop a braking effort equal to from 60 to 70 per cent of the adhesive weight of the locomotive. With the aid of the auxiliary brake, the brake shoe pressure can be raised to 100 per cent of the adhesive weight of the engine.

Encouraged by the great success attained with the Pecz-Rejto feed water purifier by the Hungarian State



Boiler for German Standard 2-10-0 Locomotive

Railways, which was referred to in the January, 1923, issue of Railway and Locomotive Engineering, the Prussian State Railways have likewise experimented with it, but because of the disastrous ending of the war for the central powers and the internal troubles in both lands, the authorities were not allowed to finish their experiments; later, in Germany they began to use a quite different contrivance, partly because the Pecz-Rejto water purifier is patented. The essence of this new contrivance is that the water passes after from the feed check valve through to a jet pipe which sprays into the steam space of the boiler; so that the water is effectually heated and its volume increased. By this means the scale and mud is precipitated. The atomizing of the water has proven itself in other regard, namely, that the precipitated mud will be more porous when it is not done.

As at first constructed the feed water purifier was without a dome and the jet pipe was turned downward. In order to prevent the water from falling directly onto the fire tubes and to give sufficient time for the salts to be deposited, a sheet iron screen, the upper part bent in zigzag is placed on each side between the shell of the boiler and the tubes. This reaches down the side of the boiler about two-thirds their height. For the purpose of collecting the mud, a mud box is placed at the bottom of the boiler whence it can be removed at intervals for cleaning. A double hand hole is placed at the top of the boiler for the removal of the mud that may have been precipitated on the sheets.

According to observations of the German "Central Railway Board," the water was heated to 300 degrees Fah. These experiments showed that the spraying of the water had many advantages, but as a whole the apparatus did not prove quite satisfactory, and they have recently experimented with a new construction. The essence of the innovation is that the water atomizer, which is formed by an ordinary pipe with a tapered end, is placed in the dome and has an upward direction with a slight bend inwardly. With this new construction the mixing of the feed water with the boiler steam is more intimate, its passage through the boiler is longer, so that the precipitation of the scale-forming salts is more abundant, and the scale is more porous. With this construction, the cover of the dome and even the dome itself can be dismounted to make possible the cleaning of its interior, the jet pipe, the zigzag sheets and the boiler itself. The zigzag sheets can be cleaned also through holes placed on each side.

These two constructions are already mounted on several passenger, freight and tank locomotives.

The locomotive is equipped with the Knorr air sander, which sands the first, second, fourth and fifth coupled pair of wheels. The location of the sand dome differs with the road. For example, in the locomotive built by the Hannovershe Maschinenban A. G., which are illustrated by our figure, one sand box is placed behind the stack and another back of the dome, whilst the Borsig Works in Berlin put the sand box and the dome under the same cover.

Further, the locomotive is equipped with Marcothy smoke-consuming apparatus. On the cylinders we find the Knorr air suction and pressure equalizer valves, standard air pump with a new distributing operation, thermoelectric pyrometer, Strube injector, steam heating apparatus and pop safety valve.

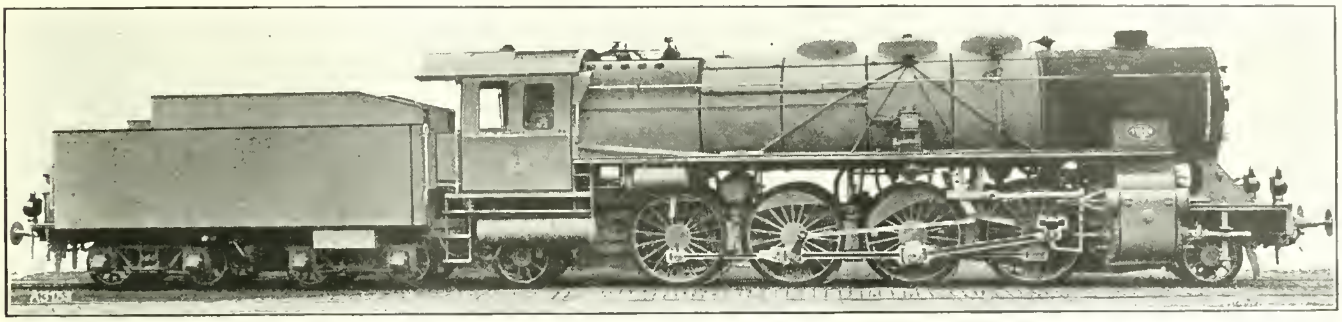
The locomotive tender is of the Prussian three axle type, having a tank capacity of 5,300 gallons of water and six tons of coal. The handbrake and the air brake acts on both sides of the locomotive. The air brake is the Kunze-Knorr system.

This locomotive was built for hauling heavy freight trains. It has hauled 1,100 tons on a one per cent grade as a speed of 9.32 miles per hour. In hilly country it has hauled 600 tons at a speed of 37.26 miles per hour and in its regular performance it develops 2,000 horsepower.

The Hannoversche M. A. G. have built 164 of these locomotives for the Prussian State Railways, while other German plants have built a number of these locomotives for other railways of the empire, so that there are now about 1,000 of them in service.

The principal dimensions of these standard 2-10-0 type locomotives which are used on the Prussian, Saxon and Elzas-Lothringen State Railways are as follows:

Cylinders, diameter and stroke	22 7/16 x 23⅝ in.
Diometer of driving wheels	55 7/64 in.
Diameter of bogie wheel	39⅜ in.
Wheel base, rigid	16 ft. 5 in.
Wheel base, total	27 ft. 10 21/32 in.
Boiler pressure	199 lbs. per sq. in.
Grate area	39.4 sq. ft.
Heating surface of boiler	2,100 sq. ft.
Heating surface of superheater	730 sq. ft.
Feed water heating surface	162 sq. ft.
Weight in working order	104 tons
Weight on drivers	89.8 tons
Tractive power	39,000 lbs.
Capacity of tender, water and coal, 5,300 gals.	6½ tons
Total wheelbase, locomotive and tender, 50 ft. 5 11/32 in.	



Mikado or 2-8-2 Type Three-Cylinder Locomotive of the German State Railways, Equipped With Superheater, Feed Water Pre-Heater and Purifier

Railway Repair Shops in Southern France

The locomotive and railway rolling-stock construction and repair shops located near Marseilles in 1919 by the Chantiers et Ateliers de la Capellette comprise the most important industry established in the south of France since the war.

The plant covers about 32 acres and has, in addition to a large diversity of factory buildings and sheds, about 12 kilometers of railway line. The shops are equipped to repair 400 railway carriages at a time, and one building, 170 by 75 meters, is able to handle 36 locomotives simultaneously. A large number of electric traveling cranes, some having a capacity of 60 tons, are in use; the entire equipment is said to be complete and modern in every way. Much of the repair work of the Paris-Lyon-Mediterranee Railway and of the Midi Railway system, as well as that of the smaller local lines, is handled by this plant.

German Diesel Locomotives for Russia

The chief of the Russian railway commission in Berlin is reported to have contracted with the Deutsche Werke for the construction of a number of Diesel-engined locomotives, according to Consul Richardson at Berlin. The first two, one with electric and the other with hydraulic transmission, must be delivered during the summer of 1923.

These new locomotives will cost approximately twice as much as steam locomotives, but they have the advantage, among others, of being capable of operation without water—a distinct improvement in a country where water is scarce. This feature will permit the extension of railways into sections of Russia where now they are nonexistent

The Stafford Roller Bearing for Railway Cars

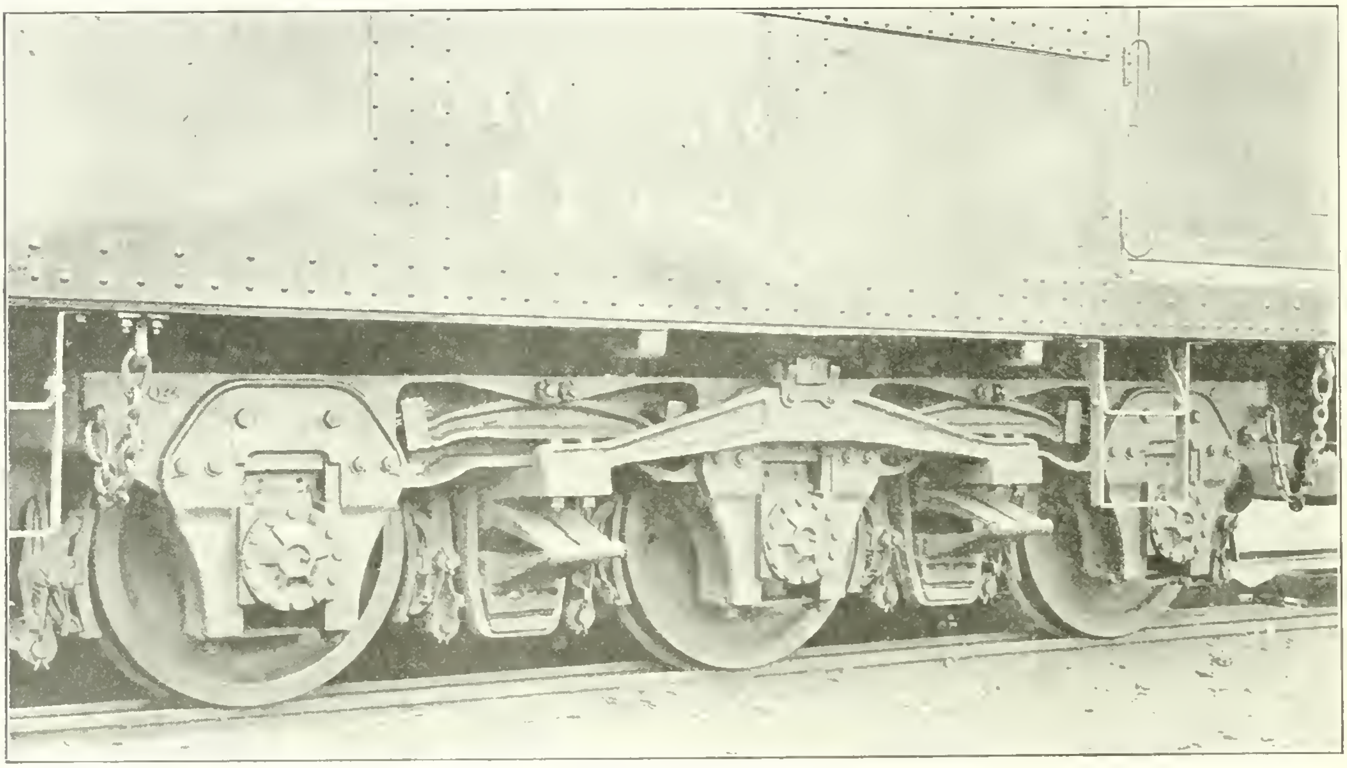
A Description of Its Design and Performance on Cars of the Michigan Central Railroad

For many years the railway car has been an attractive field for experimentation with roller and ball bearings. Bearing resistance makes up so large a percentage of the total resistance of a train that the elimination of even a small portion of it would mean a great deal in the saving effected in transportation. The latest candidate for honors in this field is the one illustrated in the accompanying engravings, and which has been in successful operation for a number of months on several cars of the Michigan Central R. R., and is being manufactured by the Stafford Roller Bearing Car Truck Corporation of Lawton, Michigan.

It has been applied to several cars of different types. In the illustration it is shown in a six-wheeled truck running under an American Railway Express Car of the Michigan Central R. R. It has also been applied to an 80,000 lbs. capacity box car and to a flat and gondola car of the same capacity.

These cars were in regular service for periods of about six months each after the bearings had been applied during which time they travelled a total of 8,375 miles; the box car, running in mixed train service, having made 3,654 miles of the total. In making this mileage the same trucks were used that had previously been under the gondola car, where they had already run 990 miles. At the end of the run of 990 miles the car was placed on the repair tracks where all boxes were opened and all parts carefully examined and measured, at which time they were found to be in practically the same condition as when originally installed, and this embraces the state of the lubrication as well, which was in such condition that nothing need have been done about it.

When the trucks were transferred to the box car, no repairs whatever were made to them except tightening a few loose nuts. The boxes were not opened nor was any lubricant applied. Immediately after the transfer, the car left Detroit for mixed train service on the Mackinaw Division.



Stafford Roller Bearings as Applied to American Railway Express Car on the Michigan Central Railroad

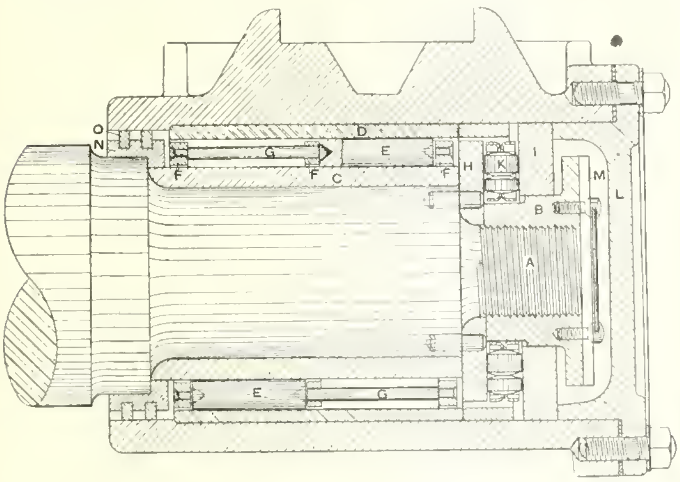
Since then, during the whole period that the bearings have been in service and after having run 25,000 miles, they have given no trouble whatever, no hot boxes have developed, and no repairs have been found necessary either on the bearings or the journal boxes.

The principal claim made for the bearing is the great reduction in resistance effected by its use. While no dynamometer tests have yet been made with cars equipped with this bearing, there is one rough test that may be used to obtain an approximate idea of its possibilities. The flat car already alluded to was loaded with axles until the gross weight amounted to 122,600 lbs., and one man was able to push this car on a level track.

As for the construction of the device, to put the matter simply, it consists of a set of horizontal rollers, held in a cage to take the vertical load and another set, held in another cage to take the end thrusts of the axle.

The axle is turned with the ordinary dust guard seat and journal bearing, the latter having a very generous fillet at the inner end. Then, at the outer end, instead of the usual collar, there is a projection *A*, which is threaded to take the adjusting nut *B*. In distinction from other roller bearings that have been tried, the turned surface of the axle journal is not used as a raceway for the rollers, but is protected by an inner bushing *C*, which is made of high carbon, high chrome special roller bearing steel which is ground and polished on both sides and then pressed on to the journal with a pressure of four tons.

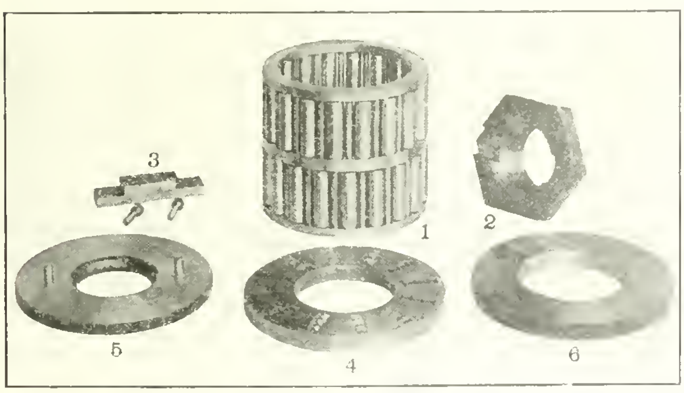
The journal box is made to fit the ordinary truck pedestals, whether for trucks having those of the regulation pattern for passenger cars or merely bolts as in the diamond type of freight truck. Its interior, however,



Vertical Section of Stafford Roller Bearing

is bored to a circular form to meet the requirements of the roller bearing. Like the axle it is provided with a raceway in the form of an outer bushing *D*, which is of the same material as that used on the axle; and is ground and polished on both surfaces and pressed into place with a pressure of 12 tons.

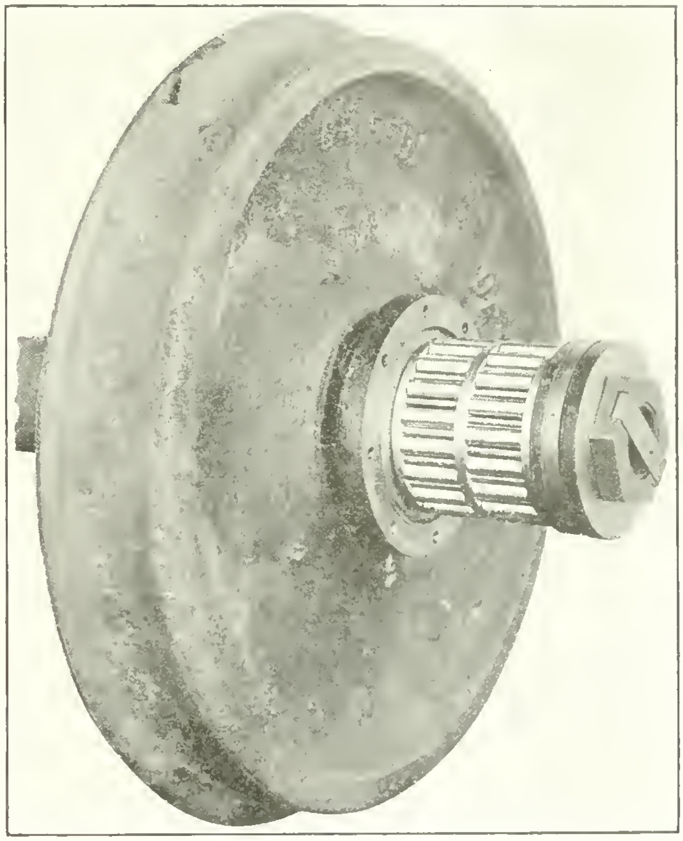
It is between these two bushings that the rollers *E* work. These rollers are held in the cage *F*. This cage is formed of three rings, held together by the spacing rivets *G*. These rivets, like the rollers, are staggered



Details of Stafford Roller Bearings—1, Roller Bearing; 2, Adjusting Nut; 3, Adjusting Nut Lock and Screw; 4, Thrust Bearing; 5, Thrust Bearing Inner Plate; 6, Thrust Bearing Outer Plate.

in the two sections of the cage, as will be clearly seen in the reproduction of the photograph of this part assembled. The rollers, themselves, are held in place on 60° centers or trunnions which set into corresponding 70° centers cut in the ends of the rollers. This allows a clearance of 10° for lubrication and also prevents any friction between the trunnions and the counterbore, in the ends of the rollers, which is ¼ in. deep. The remaining part of the rollers is solid.

The end thrust is taken by the two plates *H* and *I* with the rollers *K* between them. The plate *H* is provided with dowel pins that fit into the axle by which the two are made to turn together. The inner thrust bearing plate *H* is held in place by the adjusting nut *B* which is screwed tightly against it. The outer thrust bearing plate *I* is held in place by the inside diameter of the journal box, into which it is fitted, there being a clearance between it and the adjusting screw on the inside. It (*I*) is held up against the rollers *K* by an inwardly projecting ring cast solid with the box cover *L*. This journal box cover is so adjusted that the pressure which it exerts through the outer thrust bearing plate against the end thrust bearing rollers is neither too heavy nor too light. In short these



Stafford Roller Bearing and Thrust Plates Showing Fastening Arrangements

parts are so manufactured that the pressure against the thrust bearing assembly or parts is neither too light nor too heavy.

The adjusting nut *B* is locked by the locking bar *M* which fits in the slot in the nut, that can be seen in the reproduction of the photograph, and in a corresponding slot in the end of the axle. The locking bar is, itself, held in place by two tap bolts that are secewed in to the adjusting nut, and are prevented from turning by a wire run through small holes in their heads and tying them together.

At the back end of the box there is a dust guard. This is formed of a container plate *N* holding two packing rings *O*. The container plate is made of 40 per cent carbon steel containing 3½ per cent of nickel and is held in place by being pressed upon the dust guard shoulder of the axle with 500 lbs. pressure. The packing rings are of Hunt Spiller gun metal and are split like ordinary cylinder packing rings, the split being on an angle of 45 degrees and when the journal box is placed in position this split is closed. These rings expand against the inside wall of the journal box and are held stationary, while the container ring turns with the axle.

Referring back to the thrust bearing rollers *K* it will be noticed that they are shown in sets of two in the line engraving and in sets of three in the reproduction of the photograph. As a matter of fact they are made in both ways according to the amount of thrust that they are intended to sustain, and they are held in the bearing plate as shown.

These bearings have now been in use for more than two years and are still working smoothly and without failure.

The Sauvage Maintaining Valve

Ever since the abandonment of the original straight air system for the automatic method of brake operation, the desirability of that feature of the pioneer equipment of maintaining brake cylinder pressure against leakage has been recognized. Numerous attempts have been made to accomplish it and one of the most recent is that of William Sauvage, which is illustrated herewith.

The fundamental principle upon which it operates is dependent upon the differential in pressure that may exist between the brake-pipe and the brake cylinder. When the proper differential exists between these two places it is claimed that the Sauvage maintaining valve, as it is called, will convert the present automatic brake into what is practically, for the time being, a straight air brake; permitting a flow of air direct from the break-pipe into the brake cylinder and independent of triple valve operation.

There are three connections to be made to this valve. The one at the top *A* may be connected to the brake cylinder exhaust, that is to the pipe leading to the retaining valve or not, at the option of the company using it.

The right half connection *B* is to the brake-pipe, and the left hand connection *C* to the brake cylinder.

Under the conditions of full release of the brakes there is no pressure of air in the brake cylinder or in the retaining valve pipe, and the brake-pipe pressure then enters the maintaining valve and flow to the chamber *D* and exerts an upward pressure against the valve *E*.

This valve is held to its seat by the tension of the spring *F*, which is so set that it will permit the valve *E* to lift when the pressure beneath it exceeds that above it by 35 lbs. So that under the ordinary conditions of fully released brakes, the brake-pipe pressure lifts the valve *E* from its seat and the compressed air flows up through the hole *G* in the valve, the space occupied by the spring *F*, the restricted hole *H* and the passage *I* until it reaches the face of the valve *K* which is held down against its seat by the spring *L*.

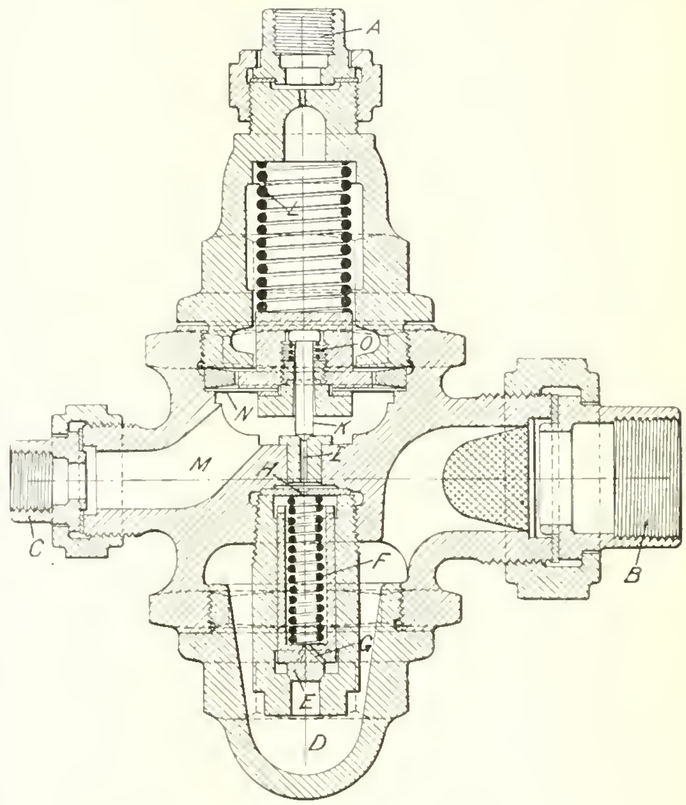
Suppose now that a brake-pipe reduction is made and the brakes applied. As soon as a pressure of 7 lbs. is developed in the brake cylinder, this pressure exists in the chamber *M*, beneath the diaphragm *N*, and acting on that diaphragm lifts it and, with it, the valve *K*, permitting the brake-pipe pressure to flow direct, past the valve *K*, into the chamber *M* and the brake cylinder.

This flow of air will continue until a difference of pressure of 35 lbs. is developed between the brake-pipe and the brake cylinder, when the latter, combined with the tension of the spring *F*, will cause the valve *E*, to close and thus cut off any further flow of air from the brake-pipe to the brake cylinder. Then, if this differential in pressure is reduced by brake cylinder leakage, the valve *E* will be again raised and the brake cylinder pressure replenished. This will continue as long as the brakes are held applied and the brake-pipe pressure is maintained.

When the brakes are released the pressure in the chamber *M* falls with that of the brake cylinder, and when it has fallen below 7 lbs. per sq. in. the tension of the spring *L* closes the valve *K* and any furthur flow of air from the brake-pipe to the brake cylinder is cut off.

Now if the top opening *A* is connected to the pipe leading to the retaining valve, it is evident that, upon the release of the brakes for recharging, there will be an equalization of the pressures above and below the diaphragm *N* and that as soon as the pressure beneath falls to be 7 lbs. or less than that above it, the spring *L* will close the valve *K*.

But if the connection *A* is left open to the atmosphere, then so long as the retaining valve holds a pressure of 7 lbs. or more in the brake cylinder, the diaphragm will be lifted and the valve *K* will be held open and air will flow from the brake-pipe to the brake cylinder, until the pressure in the latter reaches to within 35 lbs. of the former.



Details of the Sauvage Maintaining Valve

This means that under the ordinary conditions of service a 10 lb. reduction from a 70 lbs. brake-pipe pressure, should develop and hold 25 lbs. pressure in the brake cylinder. A further reduction would hold a correspondingly lower pressure in the brake cylinder; while, if the brake-pipe pressure is raised it would have the usual effect on the triple valve and cause a release of the brakes.

Incidental to the construction of the device the valve *K* is shown with a stem having a rounded head, which is held against the plunger of the diaphragm by a light spring, *O*. The only function of this spring is to hold the valve *K* up against the plunger and permit it to have sufficient lateral motion to always seat itself when the diaphragm falls

Centennial of the D. & H.

The Delaware & Hudson will celebrate its hundreth anniversary April 23, with a program of events in New York and Albany. The D. & H. is the oldest transportation company in the Western Hemisphere. It originally operated as a canal company under a charter granted April 23, 1823.

As to the Locomotive—What Next?

By G. M. Basford, Consulting Engineer, Lima Locomotive Works

Acceptance of the locomotive as the most promising single factor for reduction of the cost of transportation is proceeding rapidly. It has not always been looked upon as a possible cost reducer. There are reasons for this. Consider locomotive history, which divides itself into three eras.

First: The beginning of steam rail transportation. We must admire those who pioneered without precedent, giving us elements, principles and even construction that endured for a half century without radical changes from an engineering standpoint.

Second: The period of increasing weight and power with practically no persisting improvements, making for higher efficiency in fuel or in weight. During this time our locomotives were crude pullers of trains. Too many unmodernized locomotives are just that today. While stationary and marine engineers went rapidly forward toward higher efficiency, producing power in greater units, yielding power at lower cost, locomotive people faced transportation demands that taxed capacity. Refinements were not ready. Therefore development went to bigness, brute force and weight. This brought good things such as heavier rail, stronger bridges and capacious yards. It also brought mighty machines ready to the hand of our present engineers for application of many improvements that make for more power per pound of fuel and per pound of metal.

Third: This is our era. The era for reducing ton-mile-per-hour costs by means of improved locomotives. It is the era for coordination of the locomotive into the rapidly developing scheme of efficient railway operation. Engineers inside and outside the railways, and railway officers, executive and operating, are beginning to co-operate. Never before in locomotive history have six railroads simultaneously striven for better locomotives to reduce their cost of transportation as six roads are striving today.

Many operating officers do not yet realize how much the improved locomotive can help them. They do not yet realize how much help they need from the improved locomotive. Through a perfectly natural development these officers control the expenditures, the investments that mean most to their own success. They are the ones in general, who decide questions of investment in improved locomotives and investment in all facilities that render the locomotive more productive. Because of tradition the steam locomotive is handicapped today as to its productivity. Operating officers are in position to remove this handicap. We must tell them about it.

Mr. William Elmer throws light on this subject in his paper before the American Society of Mechanical Engineers, June, 1921. He shows that in 1920 the average freight engine earned $370 per day, or 26 cents per minute but that it made less than 60 miles per day. On another occasion (before the Central Railway Club in January, 1923) Mr. Elmer shows that for the month of October, 1922, the average daily mileage of serviceable freight locomotives was 84 miles. Are we to be satisfied with these figures?

For a $47,000 Mikado engine the fixed charges are $14.40 per day, or one cent per minute. It would be good business policy as far as fixed charges are concerned, to increase the first cost of the locomotive if a small percentage of the fuel may be saved thereby. Locomotive loading is so important as to cause a loss of $100 per day, or $3,000 per month, with an error of 10 per cent in overloading or underloading on a single division of a road having heavy traffic. This reveals the importance of the operating side of the question we are trying to answer, as the locomotive referred to burns from $10 to $15 worth of fuel per hour, and wages amount to about $4 per hour.

As to the use made of locomotives, are we to be satisfied when they are approximately but half the time in the hands of the operating officers and the other half in the hands of mechanical officers? Of course, there is a lot of avoidable delay in each case. Here is an opportunity for coordination of loading, using and maintaining locomotives that must not be overlooked.

The first Mallet to run on American rails was built by the American Locomotive Company for the Baltimore & Ohio in 1904. It was very carefully designed by Carl J. Mellin and was operated at a distance from shop facilities of any kind. From January 6, 1905, to December 31, 1910, six years, this engine was available for 40,011 hours out of a possible 50,343 hours, or about 80 per cent of the time. It was a type new to the road and new to the country. Do we do as well as that now? Can we not do as well with any and every new and also with every old engine? This engine had the personal attention of John E. Muhlfeld. Every engine needs somebody's personal attention. Does every engine get it?

Coordination of two kinds lies before us. First: The locomotive must be harmoniously coordinated as a vital element into the great transportation machine. It must fit and perform in time and in tune with physical and operating improvements, which are coming forward with great rapidity and promise. Second: The locomotive must be coordinated within itself. Every feature and factor of design must be made to harmonize with every other for the production of more ton-miles-per-dollar of total cost.

Our locomotive is a machine within a greater machine. This demands of locomotive men a thorough understanding of track, operation and signaling. It demands of operating men, track, bridge, terminal and signal men a thorough understanding of the locomotive, which must be considered as a huge investment capable of producing dividends greater than it has ever produced. It demands of engineers who would improve the locomotive a careful study of all phases of this coordination.

Locomotive Coordination Factors Outside of Itself

Recently an Eastern road invested $14,000,000 in a new line to reduce a heavy grade. It is up to the locomotive to increase the return on this investment. In railroad operation there are few features of improvement that do not directly call for corresponding improvement in the locomotive. These items require more elaboration than space and time permit of giving here. A mere list, however, reveals the problem.

Cars

Through the Canadian Railway Club Mr. E. R. Viberg shows that since the year 1876, normal freight cars have increased 285 per cent in weight and 1,080 per cent in earning capacity. Passenger equipment cars are growing heavier. Twenty years ago the heaviest passenger loco-

Abstract of a paper presented before the Pacific Railway Club, March 8, 1923.

motive weighed no more than a single dining car today, 170,000 pounds. Remember, this weight and the comfort it represents rests on the locomotive. Container cars are coming forward rapidly. So also is equipment for mechanical handling of bulk and package freight. Cars of very large capacity, used in increasing numbers, as in the Eastern coal traffic, help the locomotive by reducing the number of axles to carry a given load. Cars must be strong and heavy to provide safety and reduce maintenance. Cars represent large and increasing investments. They must not be kept waiting by the locomotive. The serious and destructive car shortages of the recent past were really locomotive shortages. Many thousands of cars waited for locomotives to move them.

Yards

Yard facilities are improving the country over. Every yard extension involves increasing difficulty as to providing land. Every improvement of a switcher reduces the necessary investment in land for yards. The switching problem calls for locomotive coordination in order to make most intensive use of yards. Those days are gone when old road engines would do for switching. Switch engines call for most careful design, that they may make every track of an expensive yard more productive. Road engines coupling to heavy trains at yards must be equipped for rapid acceleration to clear the outgoing track quickly for following trains.

Engine Terminals

Locomotive terminals would justify a chapter by itself. Many a locomotive terminal limits the productivity of the locomotive power of its road today. Every improvement in this field calls for a corresponding improvement in the locomotive to take full advantage of the investment. Think of ash pits, inspection pits, coaling stations, roundhouse and roundhouse shop facilities. These are coming forward rapidly. Soon every roundhouse will have cranes, traveling cranes and post cranes, drop pits, means for handling parts too heavy for archaic, man-killing methods, means for washing boilers quickly with hot water so that big boilers need not be damaged by washing and filling with cold water. It is a six to ten-hour job to gradually cool a boiler down. Improvements are also ready for rapid firing up of boilers, for saving time and labor in dealing with ashes, sand and coal. Again, shop equipment is receiving more attention than has been given to it for many years. But our railroad shops are many years behind the requirements. Every order for new locomotives should be accompanied by a corresponding program for more machinery and facilities for maintenance.

Water Stations

Formerly water stations were located conveniently to the water. Now water is piped for the benefit of the train service. Water is being purified, or at least rectified to the great advantage of locomotive tonnage and mileage. Boiler washing plants for washing and filling boilers with hot water are now considered as operating necessities rather than as mechanical department conveniences and they must be used for operating improvement. On a progressive road, because of its importance, water service has been placed in the charge of an independent department. The object of these things is to enable engines to move more cars and faster. Why should the engineering department build the water treating plant, the track department operate it, the mechanical department use it, and the operating department depend upon it for net earnings? Here a bit of coordination is needed.

Rails and Bridges

Rails as heavy as 130 pounds are in service, and even 150-pound rails are provided for. Track has improved. Even the obscure job of the section foreman today calls for a specially educated and very intelligent man in order to take scientific care of up-to-date track. Timber trestles are of the past. Every new bridge is a strong, heavy one. How seldom do we feel the train slow up for the bridge today. To make this great investment in roadway most productive is an important factor in considering new locomotive designs. When a railroad equips with any track improvement, its locomotives are given a better chance to increase net earnings. Even this calls for coordination.

Train Delays

Track capacity and possible increase of traffic density are being studied by means of "time-distance" charts. Dispatchers are exerting themselves to give trains a chance to run. A new term, "Main Tracker," means much today and will mean more every day. It means the making up of trains for movement, intact, through intermediate terminals to more remote destinations. Through freights are being kept out of intermediate terminals. One road is saving three-quarters of a million dollars monthly by doing this. Another road saves between 50 and 60 eight-hour shifts of switchers every day by this plan. Not every road can do as much as this, but when it can be done it gives road engines a new duty. It is important for the locomotive to measure up to an improvement that meant one and a half millions of savings to one road the first year "Main Trackers" were tried.

Elimination of train delays is the subject of deep study. Dispatching and spacing of freights is prominent in the minds of those like the Illinois Central people who seek uniform movement, using to best advantage all facilties making for maximum ton-miles per hour. As ton-miles per hour increase, cost per ton-mile decreases, the limit being when speeds become great enough to increase fuel costs above the saving in wages. But who ever reaches such speeds? Train delays appear to be more a function of the number of trains than of the loads of trains. This puts a problem up to the loomotive. Heavy tonnage, good speeds and reduction of delays are demanded. Consider what the "Peg" system means to the Buffalo, Rochester & Pittsburgh Railway. Everybody concerned in the movement of a train is told what is expected of him as to time. Delays are recorded in terms of cost. This leads to locomotive coordination most practically. On that road the plan has led operating officers to help the mechanical officers secure necessary maintenance facilities and locomotive terminal facilities. There is coordination of the highest order.

Rectified Grades

Most roads, especially in the West, were originally "located" to provide momentum grades for small engines. Fills and cuts were arranged accordingly. Some of the fills sagged and some of the cuts filled up, materially changing the grades. Some 2.2 per cent grades became over 3.0 per cent. Many of these, I am informed, have been rectified, giving heavier engines a better chance with trains that are too long for the original momentum operation.

Train Loads

Tonnage rating to give every engine every day its proper load offers opportunities for record-making savings. At least one railroad hauls all its freight in trains averaging over 2,200 gross tons each. This road hauls 5,000 ton freights at 25-mile schedules. In five years the average revenue train load of the country increased over 53 per cent. James J. Hill brought the heavy train load, but even he did not think in terms of 10,000-ton trains. Trains of this weight have been put up to a single locomotive and have been hauled successfully. Car and train loading are inseparably associated with the locomotive, requiring closest coordination in the design of new power.

Long Locomotive Runs

Formerly locomotives were designed and built for short railroads, then for divisions, because the roads grew that way. Now they must make long, continuous runs. The Southern Pacific was a leader in this change. The Santa Fe is also a leader. The Missouri, Kansas & Texas has broken all long-run records. But we must build engines that will more nearly approximate the continuous service of marine engines, and this can be done. One road does with 16 engines work formerly requiring 21 by increasing the run from 150 to 260 miles. Oil fuel overcomes one of the greatest obstacles to long, continuous runs. The locomotive must be coordinated with this operating improvement and coal burners must be made to do it. Great monetary savings are being effected by longer locomotive runs. This is one of the most important operating improvements of our day. It is one that calls for coordination in locomotive design, construction and maintenance and adequate facilities for maintenance.

Signals

Signaling is taking a new place in increasing the ton-miles per hour delivered at the outgoing end of the road. Signals are giving the locomotive a better chance to run. Their safety function is more important than ever, but their great function today is to tell trains when and how fast to go. Locomotives must coordinate with signals in increasing the capacity of single and double tracks to defer the necessity of expensive additional tracks. By aid of signals certain tracks are used in either direction to help in times of congestion. Gradually the "31" train order is giving place to the "19" order. Every change from a "31" to a "19" train order saves at least ten minutes for a tonnage train. At times it saves several times ten minutes. The Southern Pacific is a leader in this. Before long, signal indications will replace train orders of any kind as they do in the New York Central tunnel, the New York subway, the Lackawanna and other congested roads. They should be made to do it for far less congested roads. Outlying siding switches are being handled from a distance by low voltage switch machines and signals. They are controled by the dispatcher through the nearest station or tower operator. On one road six such machines saved 17,000 stops in one year aside from the saving in break-in-twos of very heavy trains. On another road those machines that save two stops for every tonnage train that takes a siding, show net earnings of 25 per cent on the investment. The mere saving in fuel is by no means the only expense avoided whenever a train is stopped and started. We stop trains too often and too easily. We should keep them moving and call some one to account for every unnecessary stop, as the steamship people do. God help the poor chap who stops a steamship unnecessarily. He is "out of a job" when he gets to the next port.

Locomotives must coordinate with these improvements and must also be ready for automatic stops and train control, which are coming rapidly. Signal people are working on a number of roads to increase average speeds from 8 to 12 miles per hour. Doubtless many roads will utilize signaling to develop "turn-around" plans for enabling locomitives to double divisions as is now being done with success on a well signaled road, the Western Maryland.

Draft Gear

For draft gear the link and pin sufficed for many years. Bigger engines and the air brake put a better gear forward. Better draft gear has brought better draft attachment to the car. Heavy trains emphasized the need. Service shocks frequently exceed the capacity of the most efficient draft gear, and the draft attachments must transfer the load to the car underframe. For this reason draft attachments must be stronger than the draft gear. A break-in-two of a heavy tonnage train is a very serious expense. Nothing on the railroad is called upon to stand the abuse that is imposed upon draft gear. What are you doing about this?

Up to the Locomotive

What must the locomotive be and what must it do to earn most for these large investments? What must it do to overcome sky-high wage and fuel costs? The next new locomotives must be built, operated and maintained to perform a new part in the reduction of the cost of transportation. Placing new locomotives on our rails for, say, thirty years of service is a matter to be approached thoughtfully. If we are to save the race against government ownership by even "a neck" we must regard the locomotive in a new light. All the new ones must be built and bought as machinery for manufacturers and ship owners is built and bought, for efficiency, for maximum earnings on the investment, the investment in everything the railroad owns. It must have appropriate attention in maintenance.

A big problem lies before operating, engineering, signal and locomotive men. It is a common problem for all. It calls for a definite and complete understanding on the part of every department of the railroad with respect to the problems of every other department. The entire railroad must be balanced as a good orchestra is balanced, by coordination and cooperation. Consider what any prominent instrument in an orchestra does when out of time or tune.

Locomotive Coordination—Factors Within Itself

This era began with plain engines. Modern locomotives are efficient and necessarily complex power plants. Between these two there is a vast difference. Improvements were developed independently, usually not by the builders but by independent companies, each devoting its efforts to its particular problem. This has brought very highly developed individual factors for increasing capacity or improving efficiency. In the combination of these factors with improved detail design, coordinating the locomotive into a truly efficient power plant, lies our present problem. Weight questions now predominate. The locomotive must be designed as a whole. It must not be condemned to run for life without certain efficiency factors because weight limits do not permit of applying them. Because of weight limits locomotives are being built today without boosters, stokers and feed water heaters. These particular engines cannot even be built for later application of these efficiency factors and must run wastefully for the next 20 or 30 years. But truly coordinated designs will permit of obtaining the savings these factors are ready to effect. Let us give a moment to some of these improvements.

Superheaters

Until the superheater came there was no persistent improvement in the use of steam in locomotive cylinders since the days of the "Rocket." Superheating has done more for the economy of cylinder performance than any other locomotive improvement. It effected an increase of 25 per cent in fuel economy, which gave a virtual increase of 33 per cent in boiler capacity. With higher superheat there is more economy or capacity to come.

The increasing demand for evaporating and superheating capacity to be provided within a locomotive boiler, the size of which is limited by physical clearances, brings the superheater designer to a point where Type "A" equipment will not always meet the conditions. The further progress of superheater design must necessarily, therefore, be along the lines of more boiler and more superheater capacity per square foot of tube area available. Naturally, the introduction of the Type "A" superheater necessitated a loss in tube evaporating surface; however, this loss in evaporating surface is more than compensated for by the introduction of the superheater, as is proven by the increased capacity of the tens of thousands of engines which have thus been fitted.

Brick Arches

Firebrick arches, old in principle, were made practical for big engines and they have added their quota to boiler capacity. Arches constituted the first step in transforming the locomotive firebox into a furnace. They led to the study of locomotive combustion and to that of heat absorption of firebox sheets, combustion chambers and flues. They baffle the gases on their way to the flues, they protect the firebox sheets from cold air and help materially to burn cinders. The supporting tubes assist the boiler circulation.

Thermic Syphon

The thermic syhon suplies two greatly needed features. First: Increased absorption surface in the firebox for radiant heat. Second: Improved circulation at the place where it is needed most, at the hottest part. This factor adds weight, but every pound of its weight is where it will do the utmost good. Efforts to provide reentering radiant heating surface from firebox sheets have been made, but never before has the maintenance problem been solved in this connection. No new locomotive should be built today or tomorrow without this improvement or its equivalent if you can find its equivalent.

Feed Water Heaters

Feed water heaters are coming forward rapidly. They catch and return to the boiler a proportion of the heat that is on its way to waste. They also reclaim about 15 per cent of the water used. They compel the exhaust steam to help the boiler and the firebox. Incidentally the feed water heater is a good example of the necessity for coordination. It calls for design and development in unison with the superheater and with other factors. No locomotive should be built today or tomorrow without this conservation feature. No marine or stationary plant is ever built without it. James Watt began its application in stationary practice. Locomotive people have not felt the need of it. But indeed they need it now. They need it for increased capacity, for fuel conservation and for elimination of water stops. Closed heaters and open heaters are now operating on locomotives with success that justifies confidence.

Lubrication

Lubrication has much to do with the length of continuous runs the locomotive can make. A bit of coordination is called for here. Do you know of a single improvement in lubrication of engine truck and trailer truck bearings that justifies a feeling of pride. Internal friction costs power in the locomotive as in every other machine. Improved guiding of locomotives by means of constant resistance leading and trailing trucks opens the way for better truck and trailer bearings. So also does the floating front axle. In fuel and in lost tonnage we are paying for improved locomotive lubrication for locomotive flexibility and high internal friction. But we do not get what we pay for. We are putting this unnecessary load on the firebox and we are punishing the track. Is not the roller bearing the real answer? Is it not time that locomotive, tender and car journal bearings should be modernized?

The Booster

Trailing wheels were added to carry heavy fireboxes. They are needed for power at speeds when high boiler horse power is demanded. The Booster puts these wheels to work at low speeds, in starting and at cricial points on grades and turns this loss to advantage at times when high boiler capacity is not needed. It helps the operating officer to increase tonnage, to increase acceleration to speeds. It is the means whereby a trailing wheel locomotive is placed in the class above itself as to tractive power. It avoids the necessity for another pair of drivers, needed in starting but superfluous when the train is rolling. The Booster is a necessary improvement. It increases the weight of the back end of the engine and we must provide for this weight. It most certainly can not be taken out of the firebox weight but must be taken care of in addition thereto. No locomotive with trailing wheels should be built without utilizing those wheels for traction in starting and on the critical points on grades.

Ash Pans

Long locomotive runs reveal weakness in this neglected item. Pans must be larger. They must have greater air openings in order to reduce the vacuum below the grates. A ratio of 14 per cent of the grate area is considered satisfactory if the rate of combustion is low enough but with 14 per cent over one inch of vacuum has been measured in the ash pan. Why not make this area of opening 20 per cent of the grate area? Why not make openings as large as possible? We should supply at least 33 per cent excess air, which means 16 pounds of air per pound of coal. Do you realize that at a combustion rate of 120 pounds of coal per square foot of grate per hour very nearly one ton of air must be supplied every hour for every square foot of grate area? What locomotive gets that much? Do you realize that at 10 pounds of air per pound of coal and a consumption of 10,000 pounds of coal per hour the firebox will demand 1,300,000 cubic feet of air, or 100,000 pounds per hour?

Grates and Grate Areas

Test plant records indicate that we are forcing fires to the point of inefficiency. Fig. 1 indicates a drop of six per cent in boiler efficiency as the rate of combustion goes up from 110 pounds of coal per square foot grate per hour to 140 pounds. Grates call for immediate intensive study. Why should the air openings through grates vary from 26 to 50 per cent in 62 cases of grate practice for soft coal engines recently studied? Differences in the character of coal do not explain this variety of figures. Who is in a position to defend such chaotic practice? Who is in position to be proud of our grate practice today?

Grate area affects losses in sparks and cinders. Run of mine coal with a large proportion of slack will make more sparks and cinders than lump coal, and what about lignite? This calls for lower velocity of air through grates. Velocities of gases through the firebox range from 100 to 300 feet per second, as fast as 200 miles per hour. We cannot wonder that this lifts sparks and cinders from the fuel bed. For years we have fired much more coal than has been burned. The stoker is doing this now because of high combustion rates.

Coal does not burn on the grates. The fire itself is mainly a gas producer. At the rate of 120 pounds of coal per square foot of grate per hour and 12.25 pounds of air supplied per pound of coal and with a high volatile coal (Westmoreland with 14,430 B. T. U. heat value per pound) 2,000 cubic feet of gas is evolved every second. A firebox of 311 cubic feet capacity is filled with gas six and a half times every second. This reveals the task we are asking fireboxes and boilers to perform. We must do our best to take as much of this heat as we can while it is in our hands. This calls for firebox volume and combustion space. These add weight. The job of the firebox is to

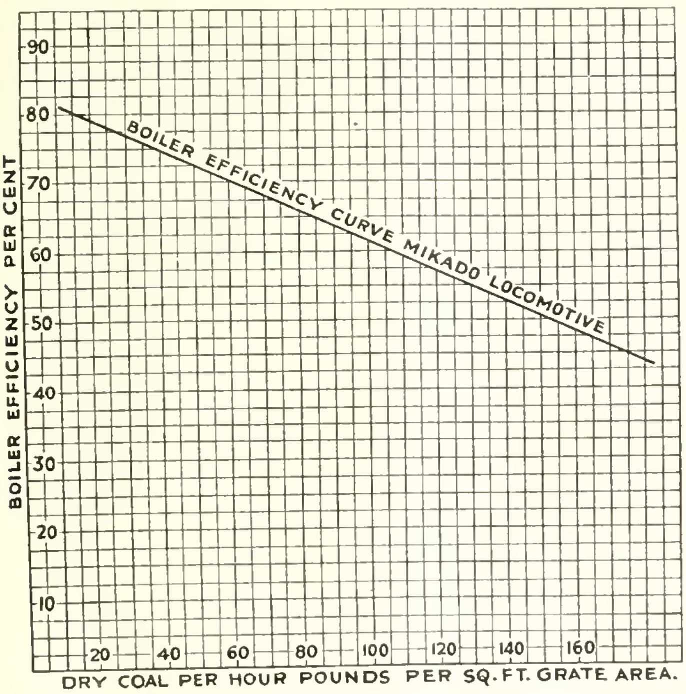


Fig. 1

absorb radiant heat. This discussion does not attempt to cover the absorption of the heat after it is created. It may be said, however, that any and all progress in the direction of reducing the rate of combustion by providing larger grates helps in the next step—that of absorbing the radiant firebox heat. When grates are large enough it is easier to get the volume the firebox requires, but this again brings us face to face with the problem of weight.

Firebox designers are faced with the fact that the firebox evaporates about 40 per cent of the total. Firebox heating surface is from 5 to 10 per cent of the total heating surface, but it effects from 25 to 50 per cent of the total evaporation.

Why is it necessary to fight for steam in a fairly well designed and proportioned coal burning firebox when that same firebox yields steam "to burn" when oil fuel is introduced? Oil burning temperatures that range about 2,500 degrees as compared with about 1,800 degrees for coal is the answer. Coal fire temperatures may be raised by forcing but with correspondingly increased spark and cinder losses. We must get greater volume of heat from coal. Oil burning in this western country has thrown a searchlight on the locomotive furnace problem It strongly suggests that we must secure more power from coal without wasteful forcing of the fire.

In locomotive service oil has always been burned in fireboxes designed for coal. Oil leaves no ash, discharges no sparks or cinders and, if it has air enough and room enough, it burns completely. In many oil burning engines, however, the combustion space is too small and the action resembles a blow pipe flame. This puts tube and firebox sheets to a test that they would not encounter if more combustion space was provided. Why not design a real oil burning locomotive firebox, which your speaker believes has never been done? Would it have a circular cross section and a long combustion chamber? To get the utmost out of oil, weight must be added at the back end. Therefore, the weight problem is common to oil and to coal burning.

In order to burn low grade fuel the Baldwin Locomotive Works built Mikado engines with wide grates, for the Bismarck, Washburn and Great Falls Railway in 1902. These are believed to be the first Mikados used in this country. The first of the type were built in 1897 for the Nippon Railway of Japan by the same builders and also for a very inferior quality of fuel.

In 1908 the Oregon-Washington Railroad and Navigation Company desired to use an extensive supply of subbituminous coal running between 8,000 and 9,000 B. T. U. heat value which was available. Their standard engines were Consolidations with 49.5 square feet of grate area, and because of insufficient grate area they cauld not burn this fuel. Mr. J. F. Graham, then Superintendent Motive Power of the road, conducted an extensive investigation of the use of low grade fuels and of grate areas. In co-operation with Mr. Samuel M. Vauclain, of the Baldwin Locomotive Works, he developed a Mikado type engine for this fuel in 1910. This engine was much larger than the Consolidations formerly used. It had a grate area of 70.4 square feet. Mr. C. E. Peck, now Superintendent of Motive Power and Machinery of the road, has very kindly supplied me with information indicating that the additional grate area of this Mikado made it possible to burn this low grade fuel very successfully. He states that it is now being burned with satisfaction in these engines. The success of this increase of grate area is highly significant in this discussion. Low grade fuel could not be burned on a 49.5 foot grate and is burned today on a 70.4 square foot grate.

High rates of combustion brought the wide firebox. The wide firebox brought the trailing wheel. The stoker eliminated the limitation of the human hand, arm and back. Locomotive improvements that make for greater capacity for efficiency and economy have delayed the next step, but increasing demand for power has again brought a limit. Again it is the firebox. Not only must we provide weight for the larger grate and the locomotive furnace, but we must have the booster and the stoker—all at the back end of the engine.

Threatening Limit to Locomotive Progress

While locomotives have been increasing very materially in size in the last few years, certain limiting features of design have not been correspondingly increased. Locomotive designers have met this limitation by the addition of front truck and driving wheels to take care of the additional tractive power.

In conventional locomotive designs the firebox has been carried by one pair of wheels located underneath the grates. The wheel load of the trailer is, of course, subject to the same limitation of weight as the drivers. In practically all modern designs trailers have been loaded up to their limit. Weights as high as 60,000 or 63,000 have been used. Most roads do not like to exceed 55,000 lbs. and some confine the limits below that figure. It is evident that the size of firebox which can be applied as related to the grate area and firebox heating surface is obviously limited by the allowable weight on the trailer axle.

In the search for means for increasing the power of the locomotive we have now come squarely up against this limitation of trailer weight. Greater and greater horsepower outputs are required which call for larger firebox volume and more grate area for burning the coal. With the present construction we are limited by the trailer wheel load mentioned above. The consequence of this has been that the size of grate area and fireboxes have not kept pace with the increase in cylinder horsepower output. An attempt has been made to make up for this by adding heating surface in other parts of the boiler which are not carried directly over the trailer, but this is only a partial remedy for the difficulty. The result is that the grate being limited as indicated, there has been a constant tendency to burn more and more coal upon a given area of grate or to increase the rate of combustion. In some modern designs the rate of combustion per square foot of grate to meet the maximum horsepower demands has gone as high as 130 pounds based upon first-class coal. In fact, the rate has gone much higher. It has been conceded that a rate of 120 pounds of coal per square foot of grate is a figure which should not be exceeded, and numerous tests indicate that if a lower rate of combustion could be secured increased boiler efficiency would result. To sum the matter up, further development and extension of locomotive power is dependent upon adequate methods of taking care of larger grate areas and firebox heating surfaces than present construction allows.

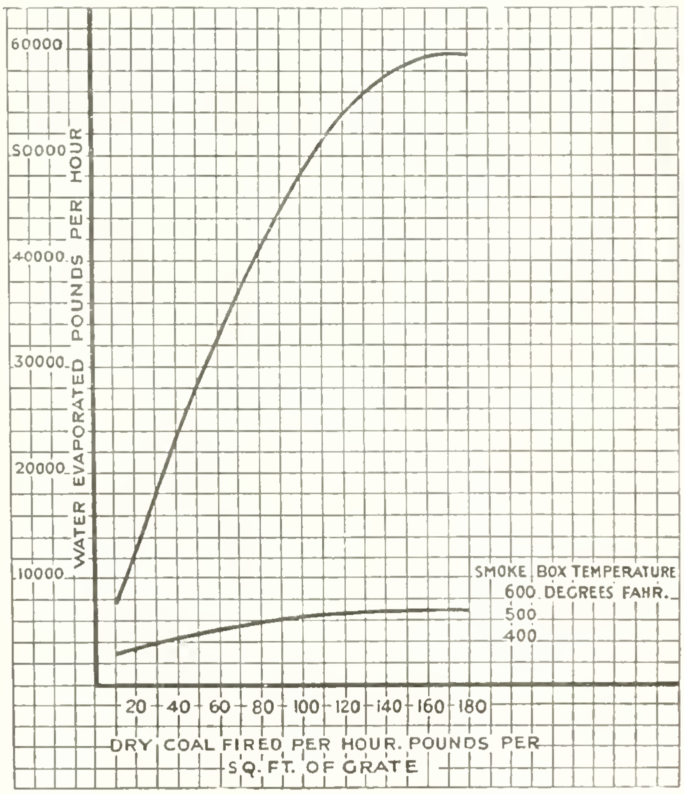


Fig. 2

Figs. 2, 3 and 4 give a good idea of the influence of the rate of combustion upon locomotive performance. These curves show total water evaporated plotted against dry coal fired per hour in pounds per square foot of grate. Fig. 2 is for a Mikado type locomotive and Fig. 3 is for an Atlantic type. Fig. 4 of the Pacific type, all of modern first-class design. In the case of Fig. 2 there is a break in the curve after about 130 pounds per square foot of grate per hour is reached. In Fig. 3 this break occurs somewhat earlier. That the performance of these boilers is not limited by the ability of the heating surface to absorb heat is shown by the smokebox temperature curve on each sheet. There is no break in this smokebox temperature curve at the point where the evaporation begins to fall off. This conclusively shows that it is a combustion condition that causes the falling off in rate of evaporation.

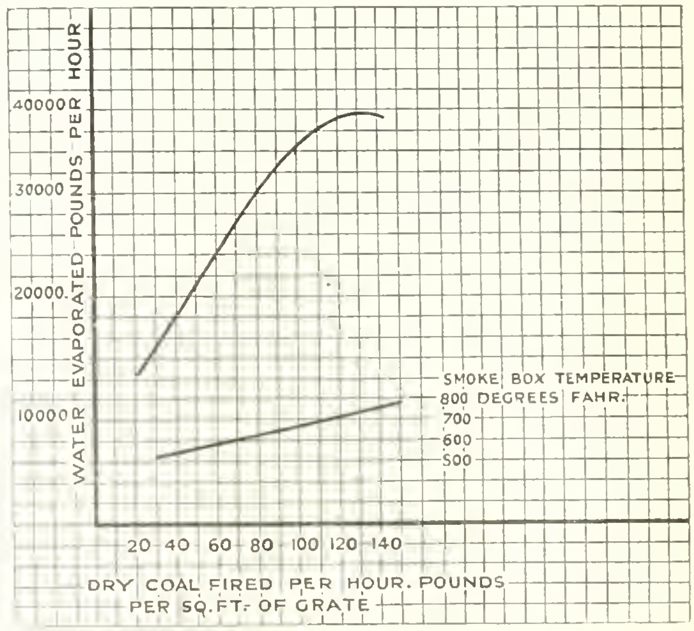


Fig. 3

Using Fig. 2 as an example, suppose that we have a locomotive designed to burn 120 pounds of coal per square foot of grate per hour, and that this design is based upon using coal of 12,500 B. T. U. If the engine receives a tank of coal averaging 11,000 B. T. U., the rate of coal per square foot of grate per hour would immediately jump to 137 pounds, at which point the curve is rapidly sloping away and proportionately a very large amount of coal must be added to secure a relatively small increase in total evaporation. Consequently the increasing rate of combustion interposes resistance to efforts to produce more power.

The condition thus cited is not an unusual one in railway practice. Reports show engines failing for steam on account of bad coal. As a matter of fact the engines failed because the rate of combustion had to be forced above the possibilities of the grate. If our locomotives were designed for about 100 pounds per square foot of grate per hour for an engine designed with the boiler proportions about as indicated in Fig. 2 we would be working on a portion of the curve where there is an even slope, and there would be a margin for the condition of poor coal.

These are test plant figures and it may be urged that they do not reflect road conditions. A road test on 4-8-2 class engine on an important road gives results as shown in Fig. 5. The average of three runs in one direction shows that 84.78 pounds of coal were burned per square foot of grate for the time the throttle was open.

The average of three runs in the opposite direction shows that 124.79 pounds of coal were burned per square foot of grate for the time the throttle was open.

This indicates conclusively that in actual practice we are duplicating test plant conditions set forth in Figs. 2 and 3.

It is also important to note that the average boiler efficiency for the lower rates of combustion was 61.71 per cent, whereas when the boiler was forced and the rate of combustion was 124.79 per square foot per hour the efficiency of the boiler fell off to 54.72 per cent. Grate area has become the most important single limiting factor in locomotive development. How to increase it and still

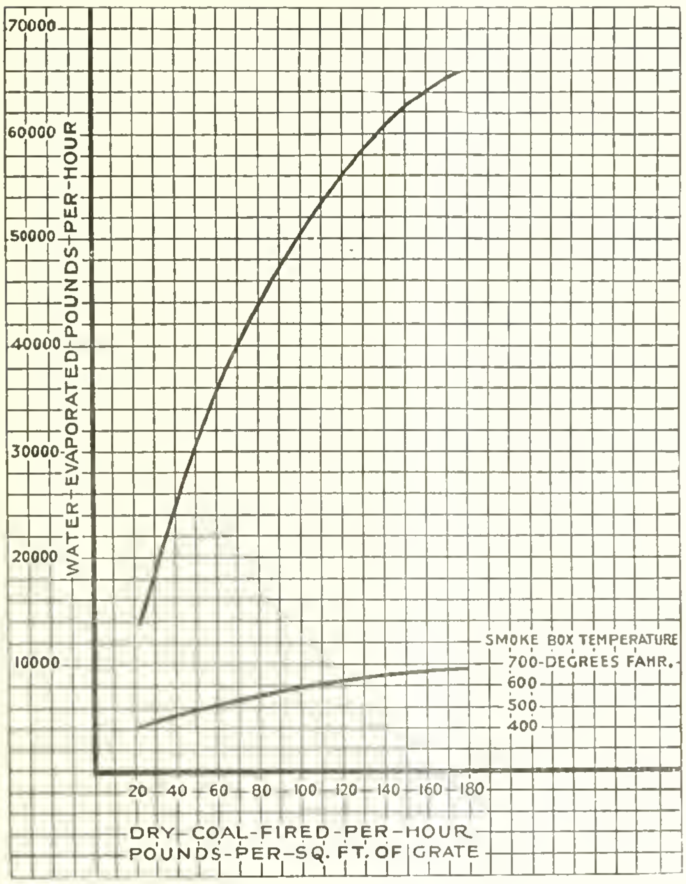


Fig. 4

meet wheel load conditions is the problem locomotive designers are facing.

The locomotive design illustrated in Fig. 6 shows a proposed solution of the problem, which has not yet been worked out in practice. This is the result of a large amount of study and planning. It is designed to permit of any desired size of firebox within ordinary limits of wheels. The frame members under the firebox are placed outside of the trailing wheels, thus giving maximum ashpan space and permitting a very easy and desirable booster, stoker and foot plate application. The cab, ashpan and cab parts are carried on supports attached to the boiler mudring. Suitable bearings are placed at the rear of the firebox connecting with the articulated frame members.

Run No.	Coal Per Sq. Ft. Grate Time Throttle Open		Boiler Efficiency (Dry Coal Basis)	
2	92.13		61.05	
4	79.59	84.78	62.04	61.71
6	82.62		62.95	
Average	84.78		61.71	
10	124.76		55.51	
12	129.36	124.79	51.01	54.82
14	120.26		57.93	
Average	124.79		54.82	

Fig. 5

This design removes the limits imposed by the single trailing axle. It permits of a grate and firebox design to suit any coal conditions and any desired rate of combustion; it allows an increase in ashpan capacity of from 75 to 100 per cent. It reduces to a minimum the lateral offsets on curves between the rear engine frame and the tender.

This Lima 2-8-4 type locomotive was designed for a limiting load of 54,000 pounds per axle. It has the following principal characteristics:

Weights in Working Order:

Engine truck	29,000 lb.
Drivers	212,000 lb.
Trailer unit (front wheels)	28,000 lb.
Trailer unit (rear wheels)	53,000 lb.
Total	322,000 lb.

Heating surface, firebox syphons and arch tubes	375 sq. ft., approx.
Heating surface, tubes and flues	3,162 sq. ft.
Heating surface, total	3,537 sq. ft., approx.
Superheating surface	915 sq. ft.
Grate area	76.2 sq. ft.

History repeats itself. In 1895 the Chicago, Burlington & Quincy found its rate of combustion mounting to 200 pounds of coal per square foot of grate per hour. Engine No. 590 with a wide firebox reduced it to 112

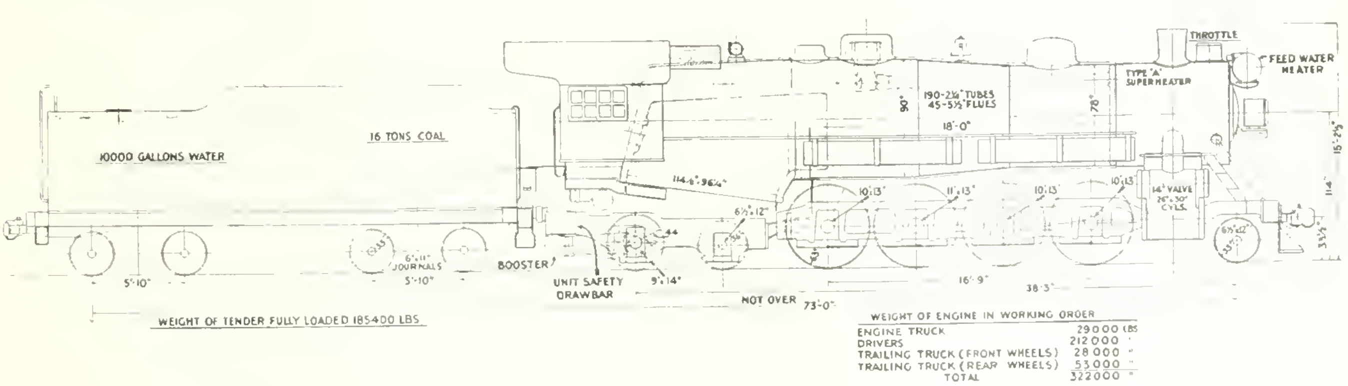


Fig. 6

pounds to do the same work. We have again reached the firebox, the grate area limit. We are again forcing locomotives beyond the point of economical operation. We are burning coal at from 140 to 180 pounds per square foot of grate area per hour. Think back to the arguments that brought wider fireboxes 25 years ago. Furnace limitations brought improvement then. They call for improvement now. We caught up then by adding a trailer axle. Another trailer axle appears to be our recourse now. Other improvements have delayed this necessity, but we must now catch up with the improvements.

Locomotive wheel action on the rail calls for a study of the wave effect of the weights imposed by the various wheels. Fiber stress in rails is affected by two things other than speeds. First, the weight on each individual locomotive wheel, and, second, the distance between the points of application of these weights. Progress of the locomotive on the track produces waves in the track. The track reacts, as much as it has time to react, after each wheel passes. Trailing wheels are far enough behind the drivers to allow the track to spring upward behind the rear drivers. The trailers knock it down again. Because of this, trailer weights are most important and so also is the distance between the trailer wheel and the rear driver. If trailer wheels carry, say, 75 per cent of the average weight on driving wheels the rail stress produced by the trailers become almost as great as the stress from the drivers themselves (American Railway Engineering Association Proceedings, Volume 21, 1920, page 719). This strongly supports the suggestion of four wheels under the firebox with wheel spacing and wheel loads that will prevent the destructive track effect of present trailer practice by an additional pair of wheels which will tend to keep the track down until the second trailer axle has passed. The four wheel articulated trailer promises to help to answer this rail stress problem.

You, in the West, are burning oil. Yes, but some day you may be faced with the necessity for burning lignite. That is what this firebox question may mean to you.

Tradition says that the locomotive must be as simple as a grindstone. Railroad operation today says that it must be powerful and efficient. Power and efficiency in locomotives are not to be had except by complication, by adding to the locomotive factors that increase power that cannot be added in any other way and factors that have waste that cannot be saved in any other way. Everyont of these factors increases weight. This weight must be provided for. In my opinion the four wheel articulated trailer is the solution. We have put the additional carrying wheels under the wrong end of the engine. Why not put them where they are most needed, under the business end, under the firebox.

Powerful Mikado Type Locomotives for the Lackawanna

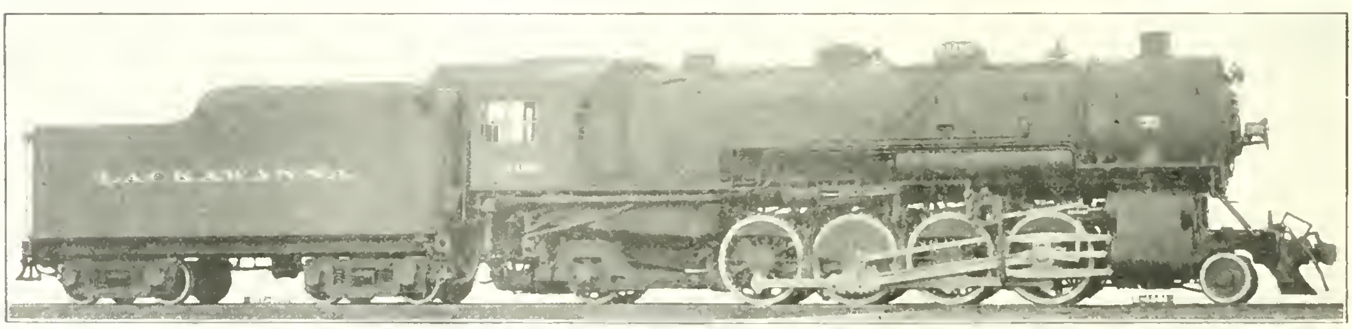
Most Powerful Ever Constructed. Develop 79,200 Lb. Tractive Effort

The American Locomotive Company recently delivered to the Delaware, Lackawanna & Western Railroad 40 locomotives of the Mikado type which in terms of tractive power are the most powerful locomotives of the 2-8-2 design that have ever been constructed, and which are of further interest since it has been authoritatively stated that their construction has postponed the necessity for electrification of a portion of this road.

A large percentage of the traffic of the Delaware, Lackawanna & Western consists of coal which is transported both east and west from the vicinity of Scranton, Pa., from which point grades of 1½ per cent are encountered in both directions, which present the most difficult operating situation on the line between New York and Buffalo. In order to equalize the operating capacity of this section of the road, plans for electrification to furnish helper or pusher service on about 40 miles of these gradients were under consideration.

While the track and bridge construction of the Delaware, Lackawanna & Western is of such substantial character as to permit the use of high capacity locomotives, the achievement represented in the locomotives under consideration is not the result of the heavy construction permissable, but rather the development of a well balanced design worked out by the American Locomotive Company to meet special traffic conditions on this road.

The weight of these engines in working order is 356,500 lbs., and their normal rated tractive force is 67,700 lbs. Being equipped with boosters, having a rated tractive force of 11,500 lbs., the total available tractive force for starting or heavy pulls is 79,200 lbs., or 17 per cent over that of the locomotive cylinders alone. The locomotive cylinders are 28 ins. by 32 ins.



Mikado or 2-8-2 Type Locomotive on the Delaware, Lackawanna & Western. Built by American Locomotive Co.

These locomotives bear the road numbers 2101 to 2140, inclusive, and in many respects are similar to the 1200 class Mikado locomotives of the Delaware, Lackawanna & Western. The new Mikado locomotives have 10,600 lbs. greater tractive force than those previously used, an increase of 18½ per cent for the main cylinders, and an increase of 22,100 lbs., or 38½ per cent, if the booster is included. The increase in tractive force was obtained by changing the piston travel of the main cylinders from 30 inches to 32 inches, and raising the steam pressure from 180 lbs. to 200 lbs. The weight of the locomotive in working order was raised from 328,000 lbs. to 356,500 lbs., an increase of 8.7 per cent, and the weight on the drivers from 256,000 lbs. to 271,500 lbs., an increase of slightly over 6 per cent.

The driving wheels of both the old and the new designs are 63 inches in diameter. The main driving journals of the new locomotives are 12 ins. by 20 ins., the front journals 10½ ins. by 18 ins., and the others 10½ ins. by 16 ins. By using lateral motion driving boxes for the forward drivers the rigid wheelbase is reduced to 11 ft. 4 ins.

Following the exhaustive tests which were made on the Delaware, Lackawanna & Western, which demonstrated the high capacity and efficiency of the Elvin Mechanical Stoker, these as well as all other new locomotives for this road are equipped with this type of stoker.

In addition to the booster and Elvin Mechanical Stoker, the other special equipment on these locomotives include the Baker valve gear, Alco power reverse gear, Butterfly type of automatic fire door, Pyle electric headlight, Cleveland water alarm, Power grate shaker, Talmadge drifting valves and Chicago flange lubricators.

The front trucks are of the Woodward type, and the trailing trucks of the Delta type.

The Miner friction draft gear is employed on the head-end to avoid damage of the pilot draw gear when the locomotives are used in pusher service.

The following are the principal dimensions of the new locomotives:

Type of locomotive	2-8-2
Cylinders, diameter and stroke	28 in. x 32 in.
Valve gear, type	Baker
Valves, piston type, size	14 in.
Weights in working order:	
On drivers	271,500 lb.
On front truck	25,500 lb.
On trailing truck	59,500 lb.
Total engine	356,500 lb.
Tender	217,600 lb.
Wheel bases:	
Driving	17 ft. 0 in.
Rigid	11 ft. 4 in.
Total engine	37 ft. 4 in.
Total engine and tender	73 ft. 2½ in.
Driving wheels:	
Diameter outside tires	63 in.
Boiler:	
Type	Straight top
Steam pressure	200 lb.
Fuel	Bituminous Coal
Diameter, first ring, inside	90 5/16 in.
Firebox, length and width	120⅛ x 84¼ in.
Tubes, number and diameter	300-2 in.
Flues, number and diameter	50⅜ in.
Length over tube sheets	18 ft. 0 in.
Grate area	70.4 sq. ft.
Heating surfaces:	
Firebox, comb. chamber and arch tubes	345 sq. ft.
Tubes and flues	4,073 sq. ft.
Total evaporative	4,418 sq. ft.
Superheating	1,112 sq. ft.
Comb. evaporative and superheating	5,530 sq. ft.
General data, estimated:	
Rated tractive force, 85%	67,700 lb.
Rated tractive force with booster	79,200 lb.
Tender:	
Water capacity	12,000 gal.
Fuel capacity	14 tons

Railroad Session at the Spring Meeting of A. S. M. E.

During the Spring Meeting of The American Society of Mechanical Engineers, which this year is being held at Montreal, Quebec, the Railroad Session will be held on Tuesday morning, May 29, 1923.

Papers of more than ordinary interest at the present time are being prepared and will be presented. One paper entitled "Construction of Steel Frame Box Cars by the Jig Method" is to be presented by H. R. Naylor, Assistant Works Manager, Canadian Pacific Railroad Company, Angus Shops, Montreal, Quebec. The paper will be descriptive of the modern methods employed at this shop and fully detail the jig method of car construction, which marks a definite step forward in the building of railway cars. The author has done a great deal in the development of this method and is fully qualified to present the topic.

The paper on "Railroad Motor Cars," by C. E. Brooks, Chief of Motive Power of the Canadian National Railways, Toronto, Ont., promises to be of more than ordinary interest. The Canadian National Railways have tested out a large number of cars of this character and experiences with and qualifications of various designs will be given.

Master Boiler Makers' Convention

The fourteenth annual convention of the Master Boiler Makers' Association will be held at the Hotel Tuller, Detroit, Mich., May 22-25. The following subjects will be reported upon with the names of the chairmen of the committees:

"Are the new combustion chamber boilers as easy to maintain as the straight standard firebox?—Henry J. Raps, chairman.

"Finished material (boiler plates) should be sound and free from cracks, surface flaws and laminations, and no hammer dressing, patching, burning or electric welding is allowed.—Charles P. Patrick, chairman.

"What are the best methods of detecting defective boiler sheets in the shop before going to the laying out bench and put into service?—John J. Keogh, chairman.

"Hammer testing of staybolts on our modern locomotive boilers is now one of the most important duties of local boiler inspectors. What is the most up-to-date hammer for testing staybolts? Give shape and weight. Is it better to hammer test staybolts while boiler is empty or under hydrostatic pressure?—J. A. Holder, chairman.

"What is the standard method of applying flues in locomotive boilers; also in stationery boilers? Give each item separately in its regular order: How should ends of flues be prepared? Preparation of flue holes in sheets. Copper ferrules, thickness and width. Give length of flue projecting through sheet at both ends. Tightening flues in sheet. Give standard tools for rollers, presser tools, beading tools.—Albert F. Stiglmeier, chairman.

"Is the use of automatic stokers on locomotive engines injurious to the firebox sheets? Do the firebox sheets crack more readily in a stoker-fired engine than in a hand-fired locomotive?—H. A. Bell, chairman.

"Care of water tube stationary boilers.—J. J. Davey, chairman.

"Steam leaks and the bad effects on the boiler plate.—D. A. Lucas, chairman.

"The life of the superheater tube and the number of safe-ends that should be applied before they are cut down for a smaller boiler.—J. P. Malley, chairman.

"What experience has been had in connection with the electric weld heater?—John W. Holt, chairman."

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Please give prompt notice when your paper fails to reach you regularly.

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The Three-Cylinder Simple Locomotive

Ever since Mr. Webb flooded the London & Northwestern Railway with his three-cylinder compound locomotives something more than twenty-five years ago, designers have been modestly flrting with the three-cylinder idea without having put it into practice on an extended scale.

The three-cylinder compound of the Webb type was not continued after he ceased to be connected with the road. The reason therefor was not explained, but, probably the difficulty of starting the engine had something to do with the decision of his successor to discontinue the use of the design. It is known that under certain conditions the valve of the low pressure cylinder might be in backward motion while the high pressure cylinders were in forward so that the two sets would be working against each other.

With the introduction of the superheater the compound, except for the Mallet type, disappeared and the single expansion came back to its own.

But the demand for continually increasing power in the ordinary locomotive, with the unalterable clearance limitations, made a problem that seemed solvable only by the use of a third cylinder.

The description of a German locomotive in another column of this issue relates to a design that has recently been developed. The cylinder diameter of a little less than 22½ in. would not be such as to call for a third cylinder to supplement its power in this country, as far as mere diameter is concerned, because two cylinders of 28¼ in. diameter would give the same increase of tractive effort that the addition of the third cylinder would give.

But the 28 in. diameter cylinder is, so far as we are aware, an unknown quantity in German locomotive work for simple engines so that it is natural to look to the appearance of the third cylinder on smaller engines than would be the case in this country. Here we go to a somewhat larger cylinder before adding the third and that has been done. Already a three-cylinder design is at work and is proving itself to be the probable predecessor of many more of its kind.

The advantages of the three-cylinder design are set forth in the article and their smooth running should be an important factor in any popularity that they may come to enjoy. Certainly the fact that the Prussian State Railways have 164 of these locomotives in service indicates that someone, at least, must have confidence in their value.

The Roller Bearing

An interesting experiment is being conducted on the Michigan Central Railroad with the use of roller bearings, the details of which are given in another column. This type of bearing, which, with its closely related bali bearing, has given such eminently satisfactory service on shafting and light vehicles that it has, for many years, led designers to apply it in the railway field. Hitherto the weight and service has been too much for the bearings as they have been applied and they have failed after a comparatively short life.

It has not yet been definitely ascertained as to just what loads the impact imposes on the journals of a moving freight car, except that it is known to be at least 50 per cent in excess of the static load on rough track, such as may be found in yards and sidings, while, on smooth main line rails it will use to 30 per cent in excess of the static load. When this is repeated several times a second it can be readily understood that the demands on the bearings in the way of endurance are very severe.

The fact that these bearings have withstood the pounding to which they have been subjected for two years and a half speaks well for their staying qualities, and the results of a continuation of the work will be looked for with great interest. If the saving in oil, waste and tractive power can meet the overhead charges of extra first cost, the device should meet with a commercial success.

The Market and the Railroad

For a few weeks past *Collier's Weekly* has been publishing a series of articles on transportation—the "Tragedy of Transportation" as the latest is headed reminds one very forcibly of the story of the office boy who, when asked as to who was the responsible party there, replied, that he did not know, except that, when anything happened he was always to blame. So the writers of these articles throw the blame of whatever happens to displease them on the railroads even though the responsibility may be infinitely removed.

For example Mr. Byron R. Newton, formerly assistant secretary of the treasury and collector of the port of New York, looks out of his bathroom window and sees some beautifully crisp lettuce growing in an adjoining field. He likes nice crisp lettuce, but when it reaches his table it is dried and withered. He cannot even go out and buy it of neighbor farmer because neighbor had already sold it and would be blacklisted by the commission dealer if he went into the retail business. So Mr. Newton had to eat stale lettuce.

Again he wandered into the fruit region of New York and found apples rotting on the ground when he was paying twenty-five cents a piece for the Oregon product. He bemoans the fact that farmers were burning grain for fuel, and in other sections potatoes were rotting in the ground. Certainly a deplorable state of affairs. But why saddle the responsibility on the railroad. What had the railroad to do with the lettuce but carry it to the commission man, to whom the farmer had sold it, and then carry it back to the retailer to whom the commission man had sold it? What had they to do with apples that had never been offered for transportation?

If the marketing methods of the country are bad, why not try and reform them instead of loading the blame on the railroads that have nothing to do with the case? He deplores the fact that the water rates, by way of the Panama Canal from the Pacific Coast to New York are less than the all rail rates to the middle west. Wasn't it the object of building the Panama Canal to bring about just that state of affairs? Why throw a fit because a sudden influx of lemons on the New York market cut the retail price in half? Was that not quite in accord with the law of supply and demand? And, if all these things check with known commercial laws, why blame the railroads who innocently carry the freight offered to the best of their ability, knowing full well that Mr. Newton and Mr. Hungerford and the other contributors to *Collier's* would be the first to set up a hue and cry that they were failing in their duties to the public.

And let us glance at Mr. Hungerford's position. He has been studying railroads long enough to know something about them, and yet his whole article rings with a plaint that short branch line traffic is not conducted with the same eye to luxuriousness of appointment and equipment that is to be found on main through lines. He complains that worn out cars are used there while the best of new steel equipment is put upon through trains.

Then he cites the case of the phenomenal growth of the North Shore line between Chicago and Milwaukee and upbraids the railroads, in general, because they do not all go out and do likewise.

Mr. Hungerford knows perfectly well that railroads cannot afford to throw away cars and locomotives until they have obtained all the service possible out of them. He knows, too, that the discomfort involved in an old coach is microscopic as compared with that of a new one except in the matter of his aesthetic sensibilities. And he ought to know, if he does not, that, the stresses to which a main line car, running at high speeds, is subjected are vastly greater, and the danger possibilities are correspondingly increased, as compared with a car in a short local train.

Why Mr. Newton should shout from *Collier's* that the railroads are responsible for the marketing conditions of the country and the price of lemons, and that Mr. Hungerford should assume that all rolling stock and all travel accommodations should be equalized, when one knows that the latter is impossible and the other that his hypothesis is preposterous.

It looks to an outsider like the carping of professional fault finders. The trouble and danger of that sort of literary work is that, it is well written, the complaints are put in an interesting way, and, when we consider that only about two per cent of their readers will stop to analyze their statements, the damage done cannot fail to be very great. They pose as friends of the railroads, yet they tell of their shortcomings, they load the shortcomings of others on their shoulders, and leave the unthinking reader with the impression that almost anybody, especially Mr. Newton or Mr. Hungerford could handle the railroads far and away better than their present managers. And this unthinking confidence rests itself on the responsible positions one of them has held, regardless of the fact that the handling of transportation has not been one of his duties.

One is reminded of a story told at the New York Railroad Club some years ago.

The club was discussing a rather knotty problem and old railroaders present were making tentative suggestions for its solution, when a college professor, with all the confidence in the world, told them exactly what they ought to do.

When he sat down a prominent general manager rose and said that the speaker reminded him of the story of a woman who had a very bad boy. He was very bad, incorrigible in fact. She had pleaded with him, beseeched him and prayed for him to no avail. Then she went to her minister to ask what she should do. He listened to her and then said: "My dear woman, I am very sorry for you, but I don't see that I can do anything for you, as I have children of my own. The only thing that I can suggest is that you go to some old maid who has never had any children."

That is apparently where *Collier's* went for its articles on railroad affairs.

The Increase in Railway Efficiency

Julius Kruttschnitt, Chairman of the Executive Committee of the Southern Pacific Company, has addressed a letter to Senator Couzens of Michigan, replying to his charge that the American railroads had not increased in efficiency in the last eighteen years and that they were now seeking to make savings primarily by wage reductions.

In his letter Mr. Kruttschnitt asserts that Senator Couzens' assumption that the chief railway economy has been reduced wages, is mistaken, and that out of a reduction of approximately $1,000,000,000 a year in labor cost of railway operation only about $350,000,000 represents decreased wages. The balance, almost two-thirds, has been the result of efficiency and economy of operation.

In 1922 the railroads carried a traffic not greatly less than that of 1920. "To do this they employed an average of 1,645,237 employes in 1922, as against 2,012,600 in 1920," Mr. Kruttschnitt says.

That Senator Couzens' statement that "for 18 years there has been no improvement in locomotive performance," is erroneous. The number of train miles per thousand pounds of tractive effort is not the measure of increase in transportation efficiency, Mr. Kruttschnitt points out. The real measure is to be found in the fact that the average number of revenue tons per train increased from 310 tons to 652 tons, or 110 per cent. "By means of this increase in efficiency of handling trains the railways secured an increase of 110 per cent in ton miles with an increase of only 20 per cent in train miles."

Stating the matter in another way Mr. Kruttschnitt shows that during the past 18 years the increase in power of each locomotive, plus the increase in the number of locomotives, produced an increase of 97 per cent in the aggregate power of freight locomotives. "With only 97 per cent increase in power they moved 139 per cent more revenue ton miles," Mr. Kruttschnitt asserts.

Another gauge of the increase in efficiency of American railroads is to be found in the amount of transportation produced for every $100 of investment in railroad property. In 1890 for every $100 of investment the railroads carried 983 tons of freight one mile, and 153 passengers one mile. In 1920 for every $100 of investment they carried 2,063 tons of freight one mile, and 231 passengers one mile, an increase of 110 per cent in freight, and 50 per cent in passenger service.

Concluding his letter Mr. Kruttschnitt says:

"You have spoken also of Mr. Henry Ford and certain methods suggested by him for effecting economy on the railroads and elsewhere. Mr. Ford's success has been in a business untrammeled by restrictive legislation and one in which he has been free to use his powers of management, his initiative, and his resources in the promotion of his business according to his own judgment. He is, of course, a novice in the business of running a railroad and his conclusions as to equipment, which you command, are at variance with the experience and the judgment of those who have spent their lives in the study of the subject."

Railway Consolidations

The question of consolidation of certain railway lines or interests is one that has taxed the ablest financiers, lawyers, and railway executives, has agitated the public mind, and been used by cheap crooked politicians to disseminate their anti-railway propaganda and poison the public mind against all corporate interest, no matter how beneficial or meritorious.

Some years ago, two large trunk lines sought to economize by consolidating certain offices in a large city and were promptly advised by governmental authority that such a scheme would not be permitted. When the railways were taken over by the government, however, the very plan which had been forbidden was by the same authority generally adopted all over the country.

The great question now to be solved is the actual consolidation of all the railways of this country into seven or four great systems under the terms of the Transportation Act of 1920. Several tentative plans have been submitted and urged by their authors and opposed by others.

As may be expected in an issue of such great moment, there is pronounced effort being made by security holders of weak and unprofitable lines to be allied with or merged into the well established prosperous lines with ample surplus, assured earnings and therefore in a strong financial position, while contra to this it is the purpose, and rightly so, of these strong lines to oppose and prevent these weak unprofitable lines being thrown upon their shoulders for protection or existence.

Prof. Ripley of Harvard University has presented one plan, President Holden of the Burlington another, and to the latter plan, R. S. Lovett, Chairman Executive Committee, Union Pacific System, made reply to the Interstate Commerce Commission at San Francisco on April 2nd, 1923, in a masterly address of some 10,000 words in which he presented a sensible business-like analysis of consolidations west of the Mississippi river, but with particular reference to what is known as the Hill and Harriman systems. All those who are interested in this subject or care to prepare themselves to be able to discuss it intelligently, should read Judge Lovett's address.

The Public Be Damned versus The Propagandist Be Damned

By W. E. Symons

Among the lowest types of humanity are the creatures who through jealousy of those of superior worth or other sordid reasons "bear false witness against their fellow men," for such is the basest form of ingratitude, and as Lord Byron well said: "An ingrate can be guilty of no greater crime."

The young, inexperienced and officious reporter who, while peeved at the results of his own indiscretions, charged the late Commodore Vanderbilt with saying, "The Public Be Damned," may not have realized the evil that would follow, even beyond the grave. As James Hill and E. H. Harriman were the empire builders of the West, so was Commodore Vanderbilt of the East, and from the best information obtainable it is safe to say that he neither made the statement, nor used language that would imply such sentiments.

After the lapse of so many years and the passing of principals, historical records must of course be consulted and these unfortunately are more calculated to confirm the statement than to condemn it. The facts as we have them from a reliable source were about as follows:

On one of the Commodore's inspection trips over the lines, and after putting in an unusually long and strenuous day's work, including interviews with reporters at the different towns and cities, he went to bed in his private car along toward midnight expecting, of course, that after giving so generously of his time through the entire day and well into the night, that he would be allowed to rest undisturbed until morning, but no, an overzealous and officious young reporter finally located the car and after tapping on windows, knocking on doors and ringing bells, raised the porter, who informed him of the facts and advised him to come around tomorrow. Ye Scribe would not have things this way and informed the porter he would stay there and ring bells and knock on doors all night, or until granted an interview for his paper, and warned that, woe be unto all those who dared not to bow the knee in his august presence, etc.

The Commodore, who was now filled with righteous indignation, very plainly informed the young man that so far as he was concerned he could go to the devil, and if he did not go quietly away and stop annoying the occupants of the car he bid fair to get an entirely different kind of an interview than he expected. The young man then conceived the idea of bidding for the public favor by falsely charging the Commodore with saying "The Public Be Damned" and doubtless millions believe it to be true.

Monumental Tribute to a Great Man

The New York Central Railway is a monumental tribute to a great man having grown to a system of 13,000 miles with annual gross income of more than three hundred millions of dollars ($300,000,000.00), and with 120,000 investors in its securities.

Some people think of railroad as they would of a farm, or a brick house, that once built it will almost last forever, and on such issues it is the deliberate purpose of the demagogue to either conceal the real truth or deliberately lie about it.

Without going into remote history, or tiresome details it may be stated that a railroad is always undergoing the rebuilding and betterment process. The rails, ties, bridges, grades, cuts, tunnels, ballast, engines, cars, buildings, water and fuel facilities, in fact, all physical things, either from decay, wear, obsolescence, incapacity, or whatever cause, constitute a constant demand on the treasury for funds which are secured by sale of securities or taken from earnings.

As to just what this amounts to on a large system, let us review the principal items on the New York Central for the past eight years:

Property investment, increase 8 years....	$340,000,000
Taken from earnings, increase 8 years......	142,000,000
Obtained from sale of securities in. 8 yrs...	198,000,000
Dividends paid to shareholders in. 8 yrs...	137,000,000

An institution of such magnitude as this great transportation unit, in the very heart of industrial America, owned by the people, operated by the people, and serving the people, should by all common sense business methods have the moral support of the people, and in like manner all our railways should be so treated, as better results would surely follow if there was greater freedom from legislative and regulatory restraints, and less insidious propaganda against railway interests in general. It would therefore seem quite fitting to actually and truthfully make the same declaration against the anti-railway propagandist, that the scribe of questionable veracity attributed to Commodore Vanderbilt some years ago.

Motor Cars for Steam Railways

During the past 20 years there has been much thought, study and expense devoted to the question of reducing the cost of all kinds of transportation, and particularly local or branch line pessenger travel. In numerous instances, train service was maintained at a loss, in fact, many branch lines would have been abandoned were it not for the fact the parent company was forced to continue operations even at a loss.

Among the various plans for relief was the motor car, gasoline, electric and steam, all having been tried with varying degrees of success, and as the cost per mile run was less than the regulation steam locomotive train, with a crew of at least four men, net economies in operation were easily shown.

Activity in this matter seems to have been less in recent years than it was some twelve or fifteen years ago, and the reason for this is not, on a careful review of the situation, hard to find.

Motor Truck Effects Rail Transportation

The first use of the automobile was as a pleasure car pure and simple, displacing as such the family horse and livery stable.

Many small tradesmen however, soon began to use their cars for commercial purposes in a small way, and soon the "motor truck" came into use, gradually but surely relegating "Dobbin" to obscurity, where speed, endurance, capacity and distance were controlling factors.

The following statistical data with respect to the automobile industry and its effect on railway traffic should be of interest:

Motor cars in United States	10,250,000
Motor trucks in United States	1,250,000
Total motor vehicles	11,500,000
Motor cars built in 1922	2,287,000
Motor trucks built in 1922	240,000
Per cent of world's registration in U. S.	81%
Number employes in motor car industries	2,431,400
Per cent of rubber supply used in motor industry	83%
Motor cars owned by corporation	600,000
Gasoline consumption in U. S. (Gal.)	5,300,000,000
Per cent of cars used more or less for business	90%
Per cent of cars used entirely for business	60%
Number cities with bus lines	108
Number motor buses in use	40,000
Number railways using motor vehicles on short lines	40
Number of motor express lines in United States	1,500
Farm products hauled by motor transportation (tons)	134,400,000
Freight hauled annually by motor trucks (tons)	1,430,000,000
Passengers carried annually by motor car	7,500,000,000

A careful study of the above statistics will make it quite clear to the average railroad man, what has already happened to the branch line and interurban, or local service, while greater inroads by the motor vehicle may be expected.

The growth or development of the country, however, is responsible for much of this motor vehicle business, although quite a large slice of it was taken from the steam railways.

Those interested in this question, however, have been, and are still working on the problem with the result that both here and abroad, there have been several new designs of motor cars brought out.

At a meeting of the New York Railroad Club, Mr. W. L. Bean of the New Haven Railroad read a very interesting paper on the subject, describing in detail and with lantern slides, a car used on their lines resulting in much economy over the steam train. Other speakers at this meeting spoke of the merits of other designs used in the same or similar service.

Car and Locomotive in One

One of the latest designs for this service is in use on the Swiss Federal line between Zurich-Romanshorn, which is a remarkable type of railroad vehicle recently designed in Winterthur, Switzerland, may be described as a combination of locomotive and passenger car. The locomotive section comprises a 250-horse-power internal-combustion engine, which is able to impart to the vehicle a speed of up to 44 miles per hour. The passenger compartment has seating accommodation for 70 third-class passengers. One or two ordinary passenger cars, according to gradients, may be coupled to the combined vehicle, thus forming short trains.

Extremely low fuel expenses are the main advantage of the new system over a steam engine service. The vehicie, which has the considerable weight of 65 tons, is said to consume only four gallons of fuel on the 20-mile line from Winterthur to Frauenfeld. The total running expenses are considerably lower than in the case of either steam or electric operation, being only about one-half as much.

Trial runs with this vehicle are being made in the presence of Federal railroad officials on the Zurich-Romanshorn line of the Swiss Federal railroads, no hitch having so far occurred.

It will be interesting to follow up the service of this and other designs, and we hope to be able to favor our readers with additional information on this subject as the art develops.

Railway Dividends Paid in 1921

A special survey of dividend distributions made by the Class 1 railroads, prepared by the Bureau of Railway Economics, shows that in 1921 dividends were declared by 71 of the Class 1 railroads, of which there are 186, leaving 115 systems which declared no dividends whatever.

The 71 companies represented 53 per cent of the outstanding capital stock of the railroads, and was worth, at par, $4,162,700,000. The total outstanding stock of the Class 1 roads on December 31, 1921, amounted to $7,302,689,000. That portion of the capital stock upon which no dividends of any kind were paid, amounted to $3,139,989,000, or 43 per cent of the stock outstanding. Of this non-dividend paying stock, the 115 companies that declared no dividends represented $2,499,714,000, the remaining $640,275,000 being the non-dividend paying stock of the 71 companies which declared dividends on some but not all of their outstanding capital stock.

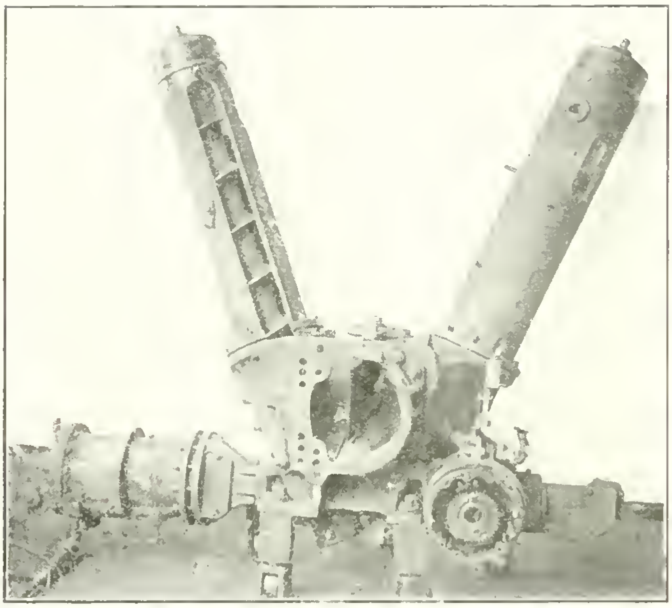
The ordinary cash dividends declared by the 71 railway companies averaged 6.4 per cent on the outstanding stock which paid dividends and, including extra cash dividends, averaged 7.2 per cent.

Railway Shop Kinks

Special Tools Designed at and for Use in the Readville Shops of the New York, New Haven & Hartford Railway

Method of Erecting and Testing Stokers

The mechanical stoker is a small power and operating plant in itself and its location on the locomotive is such that its parts are rather inaccessible and adjustments are difficult to make. Inasmuch as it is a complete unit, in itself, there is no reason why it should not be treated as such. So when a stoker is brought in for general repairs, it is overhauled and then re-erected and mounted



Stoker Assembled for Testing

on wheels as shown in the illustration. These wheels are in the form of castors and are attached to blocks bolted to the base casting of the machine.

When so mounted it can be moved about over the shop floor to any convenient place. A steam connection is then made to the engine cylinder as indicated on the engraving and the machine is run and all adjustments made until it is in proper condition for placing on the locomotive. It is then taken down and re-assembled in place.

In this way the annoyances of setting up and taking down in the erecting shop are avoided and all work can be done in the most expeditious manner possible.

Air Chuck for Lathe Turning Crown Brasses

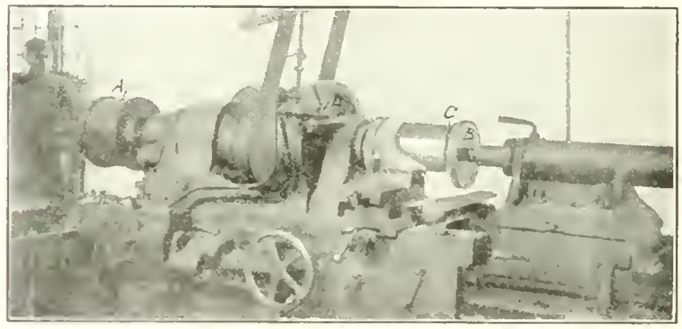
There is a lathe in the shops that is devoted to the turning of crown brasses. It is a heavy machine with a hollow spindle and under the old method of setting each brass in the chuck adjusting for centering, and tightening the clamps, it took about as much time for the set up as it did to do the work.

The time lost in setting up has been nearly wiped out by the air chuck with which the machine is shown to be equipped.

It consists of an air cylinder *A*, mounted on the spindle at the end of the lathe. The piston rod extends from the cylinder through the hollow spindle and is attached to the clamping plate *B*. This plate is fitted with pins *C* on the side towards the headstock which bear against the brass when it is in position.

An air valve *D* is set on the head-stock and a pipe is led to it from the shop air supply; and two pipes run from it to the air cylinder for the operation of the latter.

The portion of the chuck attached directly to the spindle of the lathe has a seat for the brass which centers it at that end. Then when a brass is to be put in place, the dead center in the tail stock is run back, air admitted to the back end of the air cylinder and the clamping plate *B* thus moved back. The brass is then set in place, air admitted to the front end of the cylinder, drawing



Air Chuck for Crown Brass Lathe

the clamping plate firmly against the work. The dead center is then run into place and the work is ready for turning, so that it can be centered and clamped about as quickly as it can be lifted into place.

When the turning has been completed, the dead center is run back, air admitted to the back end of the cylinder and the piece is at once free.

Attachment for Planing Back Heads for Piston Valves

This is an attachment for a double-headed planer for planing the back heads of piston valves. These back heads as shown in the illustration are usually made with the guides for the valvestem crosshead cast solidly with them. As no adjustment of these guides is possible it is very essential that they should be planed in perfect alignment with the center line of the steam chest. It is the function of the device illustrated to make this possible.

A heavy casting *A* is provided on one face of which there are turned two surfaces corresponding to that at the back end of the steam chest. These surfaces are also fitted with studs arranged like those for bolting the back head to the steam chest.

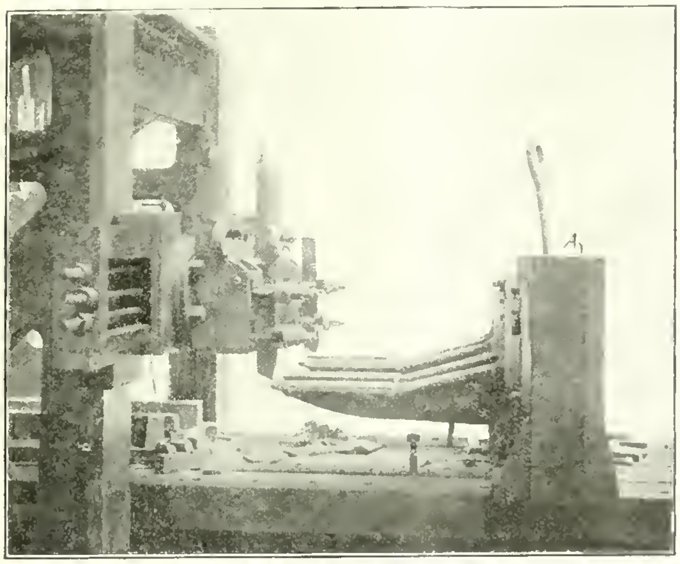
The back head is first turned to fit the steam chest end, what is the same thing the surfaces on the casting *A*. This casting is then bolted to the platen of the planer in proper alinement, and the back heads to be finished are bolted to it. The work is then so presented to the cutting tools that, when finished, its surfaces are square with the previously turned surface and will, therefore, be in line with the movement of the valve when the head has been bolted into place.

Arrangements for Boring Triple Valve Cylinders

It is a very particular piece of work that of boring out the cylinders of triple valves. It is necessary that the surfaces should be true and smooth so that the unavoidably slight leakage past the piston rings shall be reduced to a minimum. Ordinarily this work is done by carefully grinding or lapping the inner surface, and for many years the manufacturers did the greater portion of this class of triple valve repairs.

The system here illustrated by three examples, certainly appears, at first sight, to be a rough and ready method of performing an exceedingly delicate operation, and yet it does the work with all of the accuracy and nicety desired.

As will be seen from this and other articles, the Readville shops of the New York, New Haven and Hartford



Back Head Planing Attachment for Piston Valves

make an extensive use of old air motors, and this is a case of that kind.

The first figure shows the casing of an F triple valve in the process of being rebored. It is bolted fast to a bench and a nut fastens the thin flat plate *A* to the bottom of it. The nut has a bearing for the spindle of the boring bar and the plate carries two studs *BB* upon which the plate *C* is made to slide up and down. Each of these studs carries a spring, by which the plate *C* is pressed up against the shoulder on the bottom of the boring bar, while a hole at its center admits a teat projecting down from the bar and holds it in line.

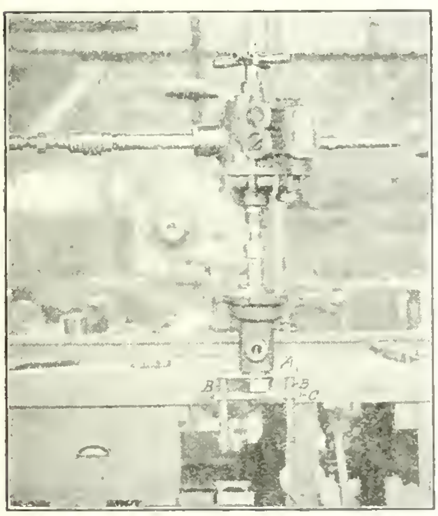
At the upper end of the boring bar the milling cutter is attached. This cutter is of the spiral type with its teeth cut at an angle of 22½ degrees with the axis.

The boring bar ends in an ordinary taper shank upon which the air motor is set. As will be seen it is of the ordinary portable type.

As the cutter is forced down into the cylinder, the shoulder at the lower end of the boring bar pushes the plate *C* ahead of it, compressing the two springs on the studs and being held in line by the hole in the plate.

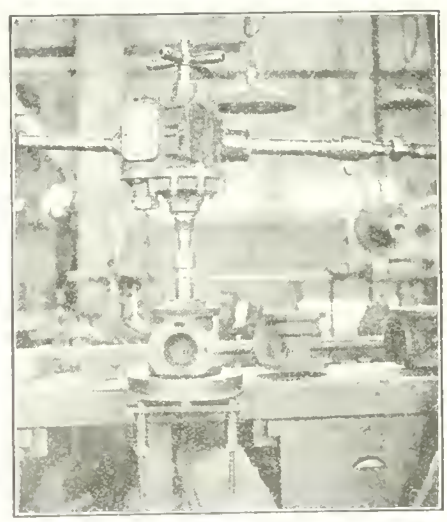
When the bar is lifted and the cutter withdrawn, the springs follow back, holding the plate against the shoulder of the bar, thus keeping it in line and preventing the teeth of the cutter from scratching the surface of the cylinder.

The same arrangement is used for boring out and finishing the equalizing portion of the P. C. equipment which is mounted as shown. Finally a much simpler method of using this same device with the K 1 triple valve is to bolt the valve to a heavy plate and then treat it as already described.



F-1 Triple Valve

P. C. Equalizing Portion



K-1 Triple Valve

ARRANGEMENTS FOR BORING AIR BRAKE VALVE CYLINDERS

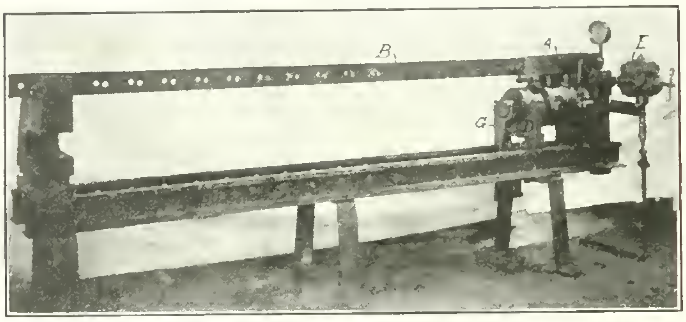
Hydraulic Press Driven By An Air Motor

This hydraulic press is used for pressing the gears on to the shafts of the Duplex stokers. An old air motor is used as a source of power. The bed plate is made of two old T rails that are carried by the six legs of flat steel, that also serve as separators for holding the two rails to the proper distance apart. The heads are planed flat on the top and sides to serve as slides for the back head and the webs are slotted to take the keys for holding the slide.

The front head is fitted to the two rails and bolted to them through the webs. The main uprights consist of two pieces of 4½ in. x 2⅝ in. steel, to which extensions of 2½ in. by 4 in. pieces are bolted. At the upper end of these extensions the link *A* is pivoted. This link is formed of two pieces of 1 in. by 4 in. steel. To and between the outer ends of these link pieces, the top bar of the press *B* is pivoted. This is of 4 in. by 1 in. steel and is slotted, as shown, to receive the keys for taking the thrust of the back head. This is a heavy casting 5½ in. thick at the bottom and tapering to 4⅝ thick at the top, and is cut away on one side to permit the shaft to be inserted.

The cylinder is bolted to the uprights of the back head and has a stroke of 7 in. with a ram diameter of 4 in. The cylinder itself is carried by the bolts that hold it to the back head while the overhang is carried by a guide *D* that is bolted to the tops of the rails of the bed plate.

The air motor at *E* is carried by a light bracket made of ½ in. by 3 in. flat steel, and its shaft passes through bearings bolted to the back head and carries a pinion of 22 teeth at its outer end at the back side of the machine. This meshes with a gear of 52 teeth, in which a crank-pin is inserted. The crank thus formed has a throw of 3 in. The connecting rod leading from this crank is in two parts so as to permit of the vertical and horizontal oscillation of its extreme ends. The outer end connects to a horizontal lever that is pivoted at one end to a link attached to the side of the cylinder, and at a distance of one quarter of its length from this end, it has a pin working in a Scotch yoke which is made integral with the pump plunger. This reduces the stroke



Hydraulic Press for Stoker Gears

of the pump plunger to ¾ in. It is ⅞ in. in diameter. A pressure gauge is attached to the back end of the pressure cylinder, and registers in tons of pressure on the 4 in. ram.

There is a relief valve on the pump cylinder which, when closed, starts and, when open, stops the action of the pump.

The retraction of the ram is accomplished by means of the lever *G*, which is provided with a jaw at its upper end by which it is pivotted to the outer end of the plunger. The lower end is pivotted to an arm reaching out from the legs beneath the cylinder that support the frame. Then, at a point between the rails that form the bedplate, there is a rod running back to a follower that bears against a spring of ½ in. steel, 4 in. in diameter and 13 in. long. As the plunger moves out this spring is compressed and when the pressure is released from the cylinder its tension draws the plunger back to its original position.

New York Railroad Club Meeting

The New York Railroad Club held its regular monthly meeting on Friday evening March 16th in the Engineering Society's Building, 29 West 39th St., and was well attended.

The subject for the evening was:

"The National Transportation System" and was most ably presented by J. Rowland Bibbins who has had a wide range of experience, having formerly been manager, Department of Transportation and Communication, Chamber of Commerce of the United States of America.

Mr. Bibbin's paper was a perspective of the status and needs of the country's second industry, and the hopeful possibilities of more complete operating unification. He presented slides showing in graphic and tabulated form a great mass of statistical information. The paper was well received by an appreciative audience, and the discussion which followed brought out many additional points of interest.

Captain Moore of Houston, Texas, emphasized the necessity of good roads in all transportation problems, particularly highways for motor trucks, and with lantern slides gave details of construction of a highway that stands up under the heaviest motor truck service.

Other speakers participating in the discussion were Daniel L. Turner, Consulting Engineer to the New York Rapid Transit Commission, Major Emerson and Colonel Chas. Hine, the latter in a very able manner defending railway managements against the charge of inefficiency.

Mr. Turner expressed the view that railroads should have a rate for transportation or hauling, and that in large cities with elaborate and expensive terminals, there should be an extra charge for terminal service, to protect capital so invested and he believed the recognition of this principle should be insisted upon.

W. E. Symons, in answer to one speaker who criticised the railways for slow car movement, called attention to the fact that hundreds if not thousands of shippers used railway cars as auxiliary storehouses, paying the demurrage for days and days, because it was cheaper in the long run than to build proper storage facilities and handle the stock twice as against one handling direct from the car, and that as result of this the railways were often falsely accused of not furnishing or promptly moving cars.

Mr. Symons also concurred in Mr. Turner's view as to a separate charge for terminal service, but pointed out that there were good legal grounds on which to establish this extra charge or differential in the Supreme Court decision in the famous Minnesota rate case. The opinion was written by Justice Hughes, now Secretary of State, and enunciated clearly the broad principles of equity involved in the following language:

"When rates are in controversy, it would seem to be necessary to find a basis for a decision of the total value of the property independent of revenue, and this must be found in the *use* that is *made* of the property; that is, there should be assigned to each business that proportion of the total value of the property which will correspond to the extent of its employment in that business."

From the foregoing it must be clear that the principle of a fair and reserved terminal charge should be recognized in any rate structure.

The paper with discussions will be a valuable addition to the club's literature.

The Pennsylvania's Equipment Orders

New equipment ordered by the Pennsylvania to be placed in service this year—some of it already being delivered—involves an expenditure of more than $57,-000,000. In order to handle its share of the country's growing business—normally about 11 per cent of the freight and 17 per cent of the passenger traffic of the nation—the company is making large additions to its present car and locomotive capacity.

Since the first of this year, the Pennsylvania has ordered 500 new steam locomotives, for delivery this year in time to be of service when business ordinarily reaches its maximum activity in the fall. In addition to those locomotives deliveries have been completed on the 100 heavy freight locomotives ordered last August. Final deliveries are now being made on 250 passenger cars ordered last year and 15 passenger locomotives being built at the company's Altoona Works.

Twelve New 180-Ton Electric Locomotives

For Passenger Service on the New York, New Haven & Hartford Railroad

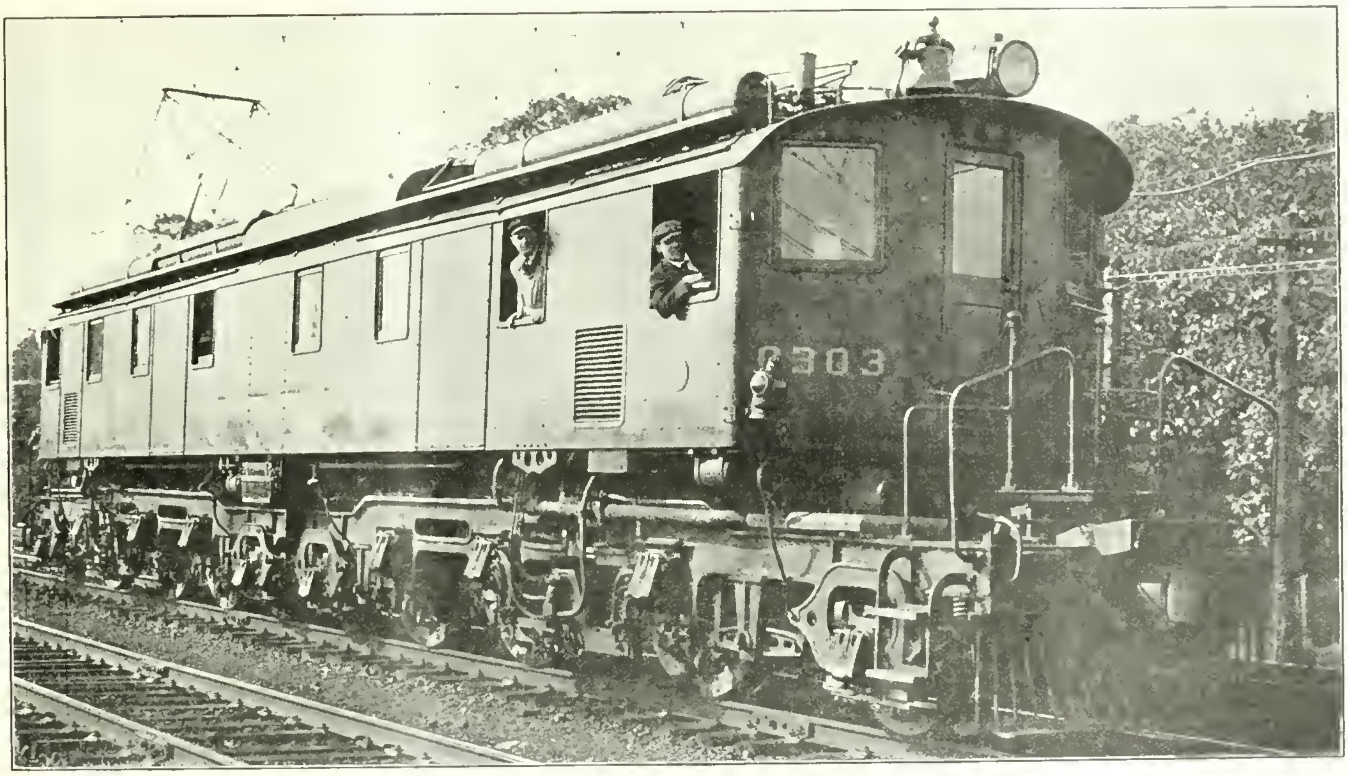
By W. J. CLARDY

General Engineering Dept., Westinghouse Electric & Manufacturing Company

The New York, New Haven and Hartford electrification is the most comprehensive in the world and embodies all classes of service on one of the foremost trunk line railroads. The main line between New York and New Haven, a distance of 72 miles, is an outstanding example of what can be done by electrification on a congested four-track section with extremely heavy freight and passenger traffic. There are almost 600 miles of electrified track, including some of the busiest main line and yard trackage in the world. Yards at Oakpoint and Westchester are served entirely by electric switcher locomotives.

The present electric motive power equipment consists of 106 Baldwin Westinghouse locomotives, 52 for passenger, 38 for freight, 16 for switcher service, and 35 Westinghouse equipped multiple-unit motor cars. The first 41 passenger locomotives, placed in service in 1906 and 1908, are the 2-6-2 type and weigh 102 tons complete. The last five passenger locomotives were built in 1919 and are the 2-6-2 + 2-6-2 type, weighing 180 tons complete. Sixteen 80-ton, 0-8-0 type switcher locomotives were placed in service in 1912, and thirty-six 110-ton 2-8-2 type road freight engines in 1912 and 1913. The first of the 35 multiple-unit motor cars were operated in 1909 and the last eight cars went in service in 1922. These cars range in weight from 84 to 91 tons complete with all equipment (no load) and are really locomotives, as each motor car is capable of hauling two trail cars.

In 1916 and 1917 a very complete study was made of the traffic requirements to determine what type of motive power was best adapted for the service. The original types of freight and switcher locomotives were considered suitable for handling the continued increase in this class of traffic. The first passenger locomotives which were built were satisfactory, except as to capacity. They had been in service only a few years when the railroad began to replace the light 40-ton wooden coaches with steel cars of 62.5 tons weight, having only about 15 per cent greater seating capacity for 58 per cent greater car weight. At the present time these locomotives have to be double headed 80 to 90 per cent of the time, and even at that do not have capacity to handle many of the heavier trains. With so many heavy trains in operation it is desirable to have a locomotive that can handle them without double heading. For these reasons a new locomotive of the 2-6-2 + 2-6-2 type was designed, which is capable of handling all of the heavy passenger trains. Five of these locomotives were purchased and placed in service in 1919.



180-Ton Baldwin-Westinghouse Electric Locomotive, Now in Operation on the New York, New Haven & Hartford Railroad

Recently twelve new 180-ton Baldwin-Westinghouse passenger locomotives were ordered and are now being built. These will be identical to the five passenger engines placed in service in 1919, except for some refinements in minor details. These engines are the 2-6-2 + 2-6-2 type equipped with six twin, 409 C-2 Westinghouse motors and will operate from a 11,000 volt, single-phase trolley or a 650-volt, direct-current third rail. The gear ratio will be 25 to 89 on 63-inch drivers and each engine will have two pantagraphs and four third rail shoes from current collection. The weight complete will be 180 tons with 122 tons on drivers.

The new locomotives will rate 2016 hp., and will develop a tractive effort of 23,200 lb. at 32.6 m.p.h. The continuous rating is 15,800 lb. tractive effort at 39.4 m.p.h. The engines have a high speed rating of 2424 hp.

and develop this rating at 45.5 m.p.h. The tractive effort is 19,000 lb. A maximum momentary tractive effort of 52,500 lb. is available and the normal accelerating tractive effort is 36,200 lb. A maximum speed of 66 m.p.h. may be attained with safety.

In designing the passenger locomotives for the New York, New Haven & Hartford Railroad there are always two factors which have to be given primary consideration. All passenger locomotives are limited to a maximum weight of 181 tons complete with all details including sand, water, oil and crew. This restriction is imposed on account of the Park Avenue Viaduct in New York over which passenger trains run when entering the Grand Central Station. The locomotives must be designed for direct-current operation from a 650-volt third rail to permit running on the tracks of the New York Central. This, of course, complicates the control apparatus.

The mechanical parts of the engine weigh approximately 175,000 lb. An interesting feature is the locomotive frame, which is a one-piece steel casting for each half of the running gear. This means two frame castings per locomotive and simplifies the construction of the engine. They are the largest integral castings ever made for a locomotive and each casting weighs 18,000 lb. Operating officials of the railroad have been well pleased with this type of frame and consider it an insurance of low mechanical maintenance.

The quill drive and details are the same as on the present locomotives and this type of flexible drive has proved very successful. It is the twin motor type and is fitted with a single gear meshing with two pinions, one on each armature shaft. The frame of the motor includes two integral bearings carrying a hollow shaft or quill, which surrounds the driving axle. Sufficient clearance exists between the axle and the quill to permit the axle to accommodate itself freely to track irregularities. At the end of the quill, a gear is mounted, meshing with the motor pinions. At each end of the quill are bolted six castings, each gripping one end of a helical spring located between the wheel spokes. The other end of each spring is gripped in a casting which is bolted to the driving wheel.

The 409 C-2 twin motor rates 336 hp. at 275-volts for one hour and 276 hp. continuous at the same voltage. The speeds at these ratings with 25:89 gear ratio and 63 inch drivers are 32.6 m.p.h. and 39.4 m.p.h. respectively. A maximum of 357 volts may be applied to each motor armature when the trolley potential is 11,000 and the locomotive is operating on the highest speed notch of the controller. The motors are the series commutator type with a resistance lead winding in the armature, and have compensating windings. This type of motor has proved very successful both on the New York, New Haven & Hartford and on other single-phase electrifications.

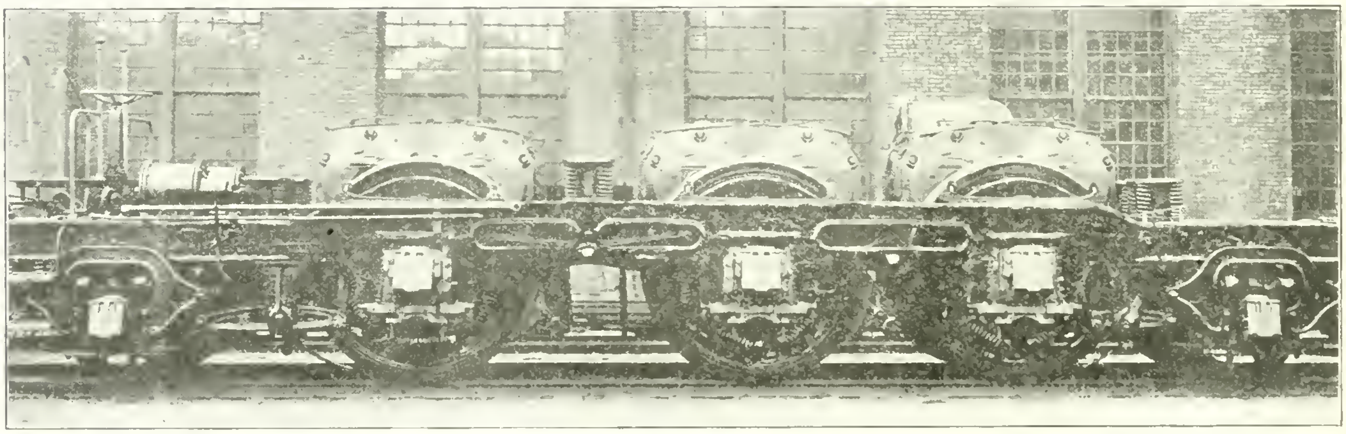
The twin motor really consists of two complete motors with a common frame, thus making a permanent double unit. This permits the most efficient utilization of the limited space available for motors and gearings and gives a more balanced design. A twin motor weighs approximately 13,000 lb. including bases, axle caps, axle bearings, dust guards, commutator lids, and gear cases. Each motor armature shaft has a pinion, and two pinions are in mesh with the gear for one pair of drivers, transmitting the power to the wheels through the flexible quill drive. The twin motor permits the use of a gear with a narrower face than could be used with a single motor of equal capacity since power is transmitted to the gear at two points. Consequently the gear requires less space and leaves a considerably greater length available for the active iron of the armature.

The A.C.-D.C. control equipment is the Westinghouse unit switch, pneumatically-operated type duplicate of that now in service. The control of an engine is handled by 28 switches, which is a real achievement when it is considered what is required of the engines. This is accomplished by connecting the motors in four permanent groups of three armatures in series. The switches are arranged in three groups: motor switches, transformer switches, and resistance switches—which assists in simplifying the control. The maintenance of the switches on the five engines now in service is practically negligible.

There are three starting and nine running notches obtained by means of voltage taps on the transformer. The locomotives have three preventive coils, which are used when accelerating on alternating-current. Nine frames of grids are provided for direct-current acceleration. The current per locomotive during acceleration is limited and is indicated by the ammeter. The controller is "notched up" at a rate that does not permit exceeding the maximum current limit for the locomotive.

Series parallel control is not provided for direct-current operation as sufficient speed can be obtained when three motors are connected in series. Series-parallel operation would complicate the control and the gain in efficiency is negligible. A field shunt, which is effective on the last controller notch gives the speed that is necessary on the D. C. zone.

The airblast transformer weighs 15,300 lb. and rates 2,100 kv-a. It has the necessary low tension taps for accelerating the locomotive and supplying power to the auxiliary apparatus. The storage batteries (used on alternate days) provide energy for operating the control switches and a motor-generator set charges the batteries.



Running Gear of Present New Haven Locomotive Showing Arrangement of Twin Motors on Driving Axles

The blowers are supplied to ventilate the transformer and main motors. There are two air compressors included with the air brake equipment, each having a 60 cu. ft. displacement. The blower and compressor motors are identical, which simplifies maintenance.

An important feature of the locomotive is the train heating equipment. Each locomotive is equipped with oil-fired flash boilers and the necessary oil and water tanks. The boiler has sufficient capacity to heat a 12-car train.

The 180-ton locomotive was selected for service on the New York, New Haven and Hartford Railroad as the best size of unit to meet all of the operating requirements. It is desired to handle all of the heavy passenger trains with a simple engine, and the 180-ton locomotive has the capacity for this work. The heaviest of the express trains consist of 12 pullman cars of 75 tons each and 900 tons trailing load. The 189-ton locomotive is capable of hauling a train of this weight between Grand Central Station and New Haven in 99 minutes on a non-stop run. This is a schedule speed of over 44 m.p.h., a remarkable performance when the numerous necessary slow-downs are considered. With stops at 125th Street, Stamford, South Norwalk, and Bridgeport, the run can be made with the same weight of train between Grand Central Station and New Haven in 115 minutes, provided the aggregate of the stop time does not exceed 7 minutes. In local service, trains of 460 tons trailing load can be handled.

The new locomotives will also operate over the New York Connecting Railroad and Hell Gate Bridge into Pennsylvania Station. They are capable of hauling a 900-ton train from New Haven to Pennsylvania Station in 110 minutes on a non-stop run. On one section of the west-bound Hell Gate Bridge approach the grade averages 1.16 per cent for 2 miles, with a maximum of 1.22 per cent. The heaviest demand is placed on an engine when it is ascending the west-bound approach on this bridge.

Twelve new locomotives are being purchased at the present time, as this number is required to provide 100 per cent electric passenger service. There has not been sufficient electric motive power to accommodate all of the passenger trains, and a number of them have not been operated with steam engines, particularly those routed over Hell Gate Bridge. Operating officials desire to handle all of the passenger trains with electric power to secure more efficient and reliable service as well as to keep the steam equipment out of the electric zone. After the twelve new locomotives are placed in service all passenger trains will be hauled by electric engines, both on the main line and on the New York Connecting Railroad.

The five 180-ton passenger locomotives that have been in service the past four years are operating successfully. They have proved their ability to perform the service satisfactorily and have an excellent record. The engines frequently make over 500 miles per day, which is a very good performance when it is considered that the longest single trip that is made is 72 miles, the distance from New York to New Haven. The record of these engines is very pleasing and substantiates the belief that this type will meet the demands of passenger traffic on the railroad for many years to come.

Another interesting fact is the record of the 41 original Baldwin-Westinghouse passenger locomotives of the 2-8-2 gearless type (O-1 to O-41). A number of these engines have now made over 1,000,000 locomotive miles and the others are very close to this figure. This is the result of 16 years of successful operation and is a very remarkable record.

The Breakage of Rails

An Abstract of a Report of an Investigation by Two French Engineers Presented to the Academy of Sciences in France

Two French engineers, MM. Georges Charpy and Jean Durand, have presented a paper to the Academy of Sciences in France on the subject of the breakage of rails.

Several observers have put forth the suggestion that one of the most frequent causes of railway rail fracture, when there is no local manufacturing defect in the metal, is due to the formation of very fine cracks on the rolling surface, which are developed at the end of a certain period. On this basis it has been suggested that it would be well to make a careful examination of the rails so that such of them could be removed as showed evidence of this defect.

The authors have assumed a different attitude in regard to the matter, and put to themselves the task of examining into the process of the formation of these cracks and then attempting to reproduce them artificially, in order to determine whether it would not be possible to find a remedy that would be less expensive and more certain than that of the removal of the affected rails.

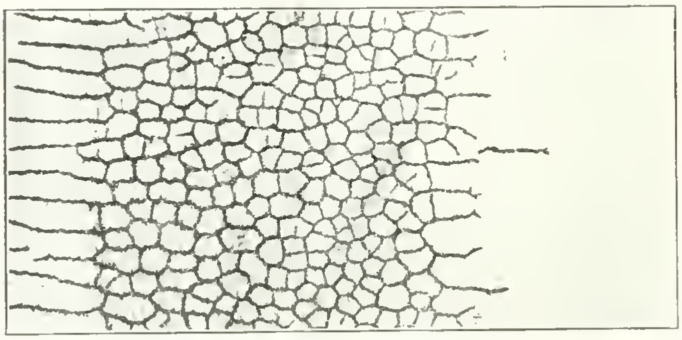
In the course of their researches they found the phenomenon to be a very general one, and one that occurs not only on railway rails, but it has been observed in a large number of cases, so that it seems to present a common characteristic of steels that have been subjected to an intense rolling effect which has been limited to a superficial layer on the surface of the metal. This layer seems, under these conditions, to be subjected to tension stresses of the same nature as those which occur, because of the variation in expansion, between a ceramic paste and its coating which causes fracture by slight vibration. The cracking of steel occurs when the metal has been so rolled superficially that it can break without any appreciable elongation.

From what has been said, it can be seen that the phenomenon should be especially noticeable in metals of a very hard variety. With white cast iron, for example, a grinding of very slight severity is quite sufficient to develop a network of fine cracks which are, in every way quite analogous to those which have been observed in rails. The same experiment (producing fine cracks by grinding) can be repeated with steels that have been rapidly tempered, as with chrome nickel metals of a hard variety (as metals for bursting shells) or with cemented steels tempered in cold water without reheating.

The cracks, which are often very fine, can be accentuated by an acid attack. It even seems that, in certain cases, the acid develops these cracks which only existed in the metal in a latent condition, which a careful microscopic examination of the surface would fail to reveal; so that the fine cracks will then be produced when the resistance of the superficial layer shall have been sufficiently weakened as a result of being made thinner by the action of the acid.

Other methods of cold rolling other than by grinding makes it possible to obtain similar results. Only a single striking example is cited. It consists of securing a cold rolling effect on a very hard metal, by making an impression on it with a ball after the method adopted in the determination of hardness by the Brinell method. Under these conditions, when the impression is examined under the microscope, fine cracks are sometimes observed, but even when the metal seems to have been left perfectly intact, the cracks can be developed as stated above, by attacking it with acid when radial cracks will be formed which are perfectly distinct and which usually assume the form of a regular star radiating from the sides of the impression. The length of these cracks indicates the extent of the cold rolling effect produced by the ball around the imprint itself. This experiment can be very readily made on tools that have been rapidly tempered, or upon the points of shells intended to burst.

In steels of average quality having a tensile strength of from 90,000 to 100,000 lbs. per sq. in., the total superficial cold rolling is much more difficult to obtain. It is then impossible to produce this result by grinding. In order to reproduce the phenomenon observed in rails, they had recourse to an analogous process originally pointed out by Duguet, who called attention to the similarity of the work done by the wheels of a train and by the rolls of a mill. The test is easy to make if we utilize the same rolls on steel of semi-hard quality as are used in the manufacture of rails. Now, on a large number of these cylinders there has been observed, after they have been in service for a certain length of time, that they develop identically the same kind of fine cracks as are produced in rails. And the same phenomena have been observed on the cylindrical trunnions of rolls for steel.



Surface of 82 lb. Rail Broken in Service. The Fine Cracks Were Clearly Visible to the Eye on the Polished Surface. Enlarged to Twice the Natural Size

A case may be cited which seems, at first sight to be quite different from those referred to above; it is that of the erosion of the bore of cannon, which has been the subject of numerous investigations by Professors Howe and Fay. By an examination of the rifling at the time when the erosions begin, it is possible to recognize the presence of fine cracks which are identical with those found on rails and rolls and which are attributed to the cold rolling produced by the bands on the projectiles and the friction upon the rifling.

This case like that of the rolls leads to the conclusion that these fine cracks are more readily formed in semi-hard steel when the temperature is somewhat above the normal. This ought not to be at all surprising because we have known, for a long time, that cold rolling is particularly dangerous for steel raised to such a temperature that it is discolored by oxidation, that is blued. In the case of rails this condition may be caused by the slipping produced by a sudden application of the brakes, whereby an elevation of temperature is produced.

All that has been said merely serves to show that the cold rolling needed to develop these fine cracks in semi-hard steel, cannot be produced instantly but requires the gradual hardening of the surface. Statistics seem to sustain this point of view, for if, taking the reliable reports that have been made by the large railway companies, we draw a curve representing the number of broken rails in terms of their length of service, it will be found that there will be a sudden change in the direction of that curve at the end of about ten years, beyond which the number of failures, which had previously been very small, increases rapidly. Here is, then, a progressive aging of rails, at least in this case, in which ten years represents the critical age, and the fact itself suggests the remedy.

The hardening produced by cold rolling can, in fact, be stopped at any time by a suitable annealing or reheating; if the annealing is done before the fine cracks are formed, the alteration effected is quite done away with; the effect of the aging is wiped out, and it may be said, to use the same figure of speech, that we have a rejuvenated metal, which replaces the old in, practically, its initial condition. This conclusion can be easily substantiated by means of the impression of a ball upon steel, as cited above. If, after having made the impression, we anneal the metal, we can then attack it to a depth with acid without causing the slightest crack to appear.

In the case of rails this surface annealing is comparatively easy to effect: A device has been developed, which consists of a heating apparatus mounted on wheels, the purpose of which is to produce a surface temper; the same apparatus can be more readily adapted to do annealing. By annealing before the critical age of ten years, it is thought that the number of failures due to these fine cracks can be considerably decreased.

Every time a piece of metal is subjected to a change by cold rolling, which develops gradually in service, and there are numerous examples outside of rails, such as chains, bolts, stays, etc., it is possible to combat that effect by annealing applied at convenient intervals; it is possible, so to speak to apply a "thermic cure" which will add considerably to the life of certain metallic parts, and this offers a source of economy in the use of metal that ought not to be neglected.

Automatic Signalling on the Mersey Railway

There has recently been erected on the Mersey Railway, England, a signalling installation which is of a unique character, since it includes the automatic operation of points.

Just over twelve months ago, there was brought into service on this line, and has since been operating most satisfactorily, a system of automatic signalling between Hamilton Square, Birkenhead, and Liverpool Central (Low Level) Stations. This signalling arranged for additional signals in the river section of the tunnel, and was of particular technical interest, in that the track circuits had probably the lowest ballast resistance of any previously installed. At the time the signalling at Liverpool Central (Low Level) Station itself, was still of the mechanical type, and SYX Lock and Block Instruments were fitted at the two cabins which were used to operate the station. The increasing traffic on the Mersey Railway has caused the General Manager and Engineer, J. Shaw, M. Inst. C. E., to consider the question of improved signalling arrangements at this station, which would enable an even more frequent service of trains to be run.

As a result of his study of the conditions, Mr. Shaw very courageously decided to take advantage of the latest appliances now available, and install at this station apparatus which would arrange for the throwing of a cross-over road and a pair of catch points, with their necessary signals, automatically.

Strength of Flanges of Cast Iron Car Wheels

By J. M. Snodgrass and T. H. Guldner

In the March issue of Railway and Locomotive Engineering, an abstract was published of a portion of bulletin No. 134 issued by the University of Illinois setting forth the strains developed in car wheels under the combined effects of wheel load and flange pressure.

Having determined the stresses and strains to which wheels are subjected, it was essential to know the strength of the flanges to resist them. A series of investigations were, accordingly, made in order to determine the strength of flanges of certain contours. These formed the latter part of the bulletin under consideration and are here given in abstract.

In order to determine the ultimate strength of the flange of chilled iron car wheels a special beam was built up of channels and plates as shown in Fig. 3. After placing the apparatus on the weighing table of the 600,000 lb. testing machine the wheel was placed in position, and supported at opposite points on the diameter of the wheel by a piece of tool steel pressing against the flange and by a circular piece of steel supporting the tread. By varying the relative position of the block and wedge opposite the position at which it was intended to break the flange, the point of load application of the flange could be shifted. This block and wedge were further necessary to balance the horizontal component of pressure due to the angularity of the flange at the point of contact. Three to six fractures were made on each wheel.

A number of wheels after being cast had the flanges ground to represent various stages of wear, so that the ultimate strength of flanges as found thereon furnish values for use in judging the safety of wheels similarly worn in service. As previously stated, variations were also made in the point at which the pressure was applied to the flange and these furnish data for use in connection with wheels operating on improperly maintained track on which wheels may strike frogs, switches, etc. Tests were made with a view to determining the variations in the ultimaate strength of the flange with variations in the flange thickness and the position at which the flange pressure is applied. Irregularities, however, exist in the data from these tests which preclude correct deductions concerning flange thickness. The irregularities present in the results are caused by differences in the various wheels as to depth of chill chemical composition, physical properties of the metal, etc. In order to correctly determine the effects of additional metal in the flange region these differences were eliminated by making wheels, from special patterns, in which one-half of the circumference had the standard M. C. B. flange and the other half had additional metal on the inner face. Three types of wheels were cast and from these the effects in both new and worn wheels of (a) thickening the flange, (b) thickening the tread, and (c) thickening both the flange and tread simultaneously were determined. To make the comparisons still more direct the loads were in every case applied to the flanges of these specially prepared wheels on a radius midway between the points where two adjacent brackets entered the tread, thus eliminating as far as possible the complex support of the brackets. In addition the flange pressures were applied at identical distances below the tread thereby removing also the effect of difference in the moment of the load. Because of these facts it is felt that the results for the wheels cast from the specially prepared patterns are truly representative of the effect due to the various additions of metal.

As to the effect of varying the position at which the pressure is applied to the flanges it was found that in general, if the side thrusts be applied to the flange on a radius *midway* between the points where two adjacent brackets enter the tread, the flange pressure necessary to produce failure in the case of the wheels with *worn* flanges is an inverse function of the distance of the point of pressure application from the tread, that is the greater the distance the smaller the ultimate strength of the flange.

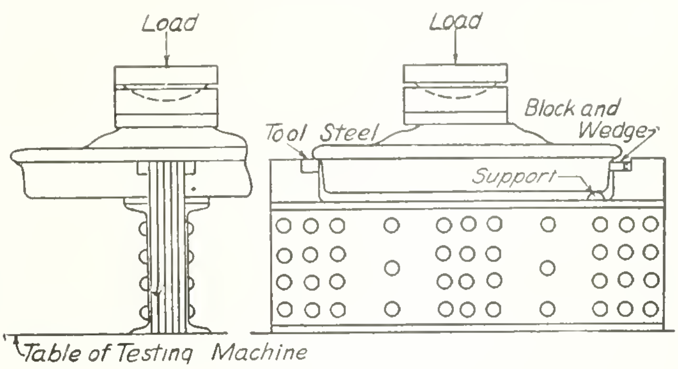
The following data are taken from a typical case of this kind:

Fracture No.	Thickness of flange	Distance of Pint of applicatin n Below tread	Pressure Required to break.
1	1.22 in.	0.90 in.	30,400 lb.
6	1.26 in.	0.63 in.	36,300 lb.
4	1.29 in.	0.51 in.	48,600 lb.

A condition of this kind is to be expected and is present in all of the data on worn wheels when the thrust is applied at the mid-position between two adjacent brackets. The statement that the greater the distance from tread to point of load application, the less the ultimate strength of flange, does not hold however, in the case of flanges not worn or only slightly worn as is apparent in the following data:

Wheel No.	Fracture No.	Thickkness of Flange	Distance of Point of application below tread.	Pressure Required to break.
04476	3	1.49 in.	0.61 in.	86,300 lb.
	5	1.52 in.	0.49 in.	63,300 lb.
942682	5	1.76 in.	0.55 in.	95,600 lb.
	3	1.71 in.	0.28 in.	79,000 lb.
107348*	1	1.53 in.	1.26 in.	109,600 lb.
	3	1.63 in.	1.09 in.	90,500 lb.
103219	2	1.63 in.	0.82 in.	92,000 lb.
	4	1.72 in.	0.60 in.	88,300 lb.

When the load is applied to the flange on the same



Apparatus Used to Determine Ultimate Strength of Flanges

radius that on which the bracket enters the tread the above mentioned inverse relation between distance from tread and ultimate strength again does not hold and certain variations occur in the data which indicate a complex supporting effect due to the bracket.

In ordinary wheel service the rail pressure is applied to the flange at a small distance below the tread and the fractures in which the load was applied closest to the tread will best represent the type of flange failure to be expected in service.

Consequently the pressures required to break the flange when applied close to the tread will be more representative of the flange strength of the wheel in normal service than the pressures which produced fracture when applied farther from the tread.

For a number of years the Association of Manufacturers of Chilled Iron Car Wheels have urged the thickening of the flange of the wheel. Tests were, accordingly, made in order to determine the effect on the strength of the flange of this increase.

To show this effect a special pattern was made in which one half of the circumference had the present standard flange and the other half had the A. M. C. C. W. proposed flange. Six wheels of this type were cast, of which three were tested after being ground to represent worn flanges and three were tested with the flange as cast.

The following table gives the results obtained from the tests of such wheels:

Ultimate Strength of Flange

	Distance of Point of application Below Tread in.	Standard M. C. B. Lb.	Proposed	Ratio proposed to Standard
158505	0.40	45,500	42,200	0.93
(Worn Flange)	0.40	50,600	47,000	0.93
158511	0.42	47,300	52,300	1.10
(Worn Flange)	0.42	48,400	54,800	1.13
132648	0.80	35,800	39,400	1.10
(Worn Flange)	0.32	38,900	76,500	1.96
158506	0.22	75,800	113,000	1.49
(Flange as cast)	0.22	88,200	118,200	1.34
158510	0.23	88,000	115,200	1.31
(Flange as cast)	0.23	92,800	119,800	1.29
132649	0.71	54,900	74,200	1.35
(Flange as cast)	0.25	74,900	94,600	1.26

With the exception of the first wheel mentioned in the table the proposed flange was in each case stronger than the present standard flange. For this wheel the outer diameters of the flanges show that the chiller was not concentric with the mold when casting this wheel. This eccentricity resulted in increasing the distance through the tread on the half having the standard flange and decreasing the corresponding distance on the half having the proposed flange, the difference in distance or thickness being about ⅛ inch.

A consideration of all the results obtained concerning the ultimate strength of flanges seems to indicate that if either the flange or tread be given a definite thickness and the other be varied a certain relation or ratio will exist between the thickness of the tread and of the flange which will result in a maximum flange strength for the particular thickness which was held constant. Assuming the existence of such a relation, it follows that the addition or subtraction of metal to the flange or tread alone, but not to both flange and tread, may result in no further increase in flange strength but may even result in a decreased flange strength. It is probable that the greater thickness through the tread of that part of wheel having the standard flange accounts for its greater ultimate strength, in that ratio of flange to tread thickness was more nearly the ideal in the case of the standard flange portion of the wheel than it was in the case of the proposed flange portion of the wheel.

If on account of the unusual flange and tread proportions due to the misplaced chiller the data for this one wheel is excluded in considering the differences between the standard and proposed flanges the results from the remaining five wheels mentioned in the table, show the ultimate strength of the proposed flange to be from 10 to 96 per cent stronger than the standard flange. This table also shows that with flanges as cast the advantage in favor of the proposed flange ranges from 26 to 49 per cent. These increases in strength were obtained by the addition of 15 lb. of metal per wheel. Since these specially prepared wheels were made from 725 lb. M. C. B. patterns and the added metal represented 2.1 per cent of the weight of the wheel. From the above it may be concluded that 2.1 per cent of metal added to this type of wheel as suggested by the Association of Manufacturers of Chilled Car Wheels increases the ultimate strength of the present standard M. C. B. flange, while new, roughly from 26 to 49 per cent. As the wheel approaches the condemning limits through flange wear the advantage of the proposed flange is apparently somewhat less than for new flanges. The results for the two worn wheels considered indicate a gain in strength of from 10 to 13 per cent in 3 cases and of 96 per cent in one case for the thicker flanges. It is likely that similar effects would obtain if tests were made on M. C. B. type wheels of different weights or on arch face type wheels. Variation in thickness of the tread and in the support given to the tread might, however, in the case of differently proportioned wheels, produce results more or less at variance with those here presented. Additional experiments with other types of wheels might be desirable in this connection.

To show the effect of thickening the tread without thickening the flange one wheel was cast in which half the circumference had the standard M. C. B. thickness of tread and the other half was thickened about 3/16 inch in the tread.

Ultimate Strength of Flange

Wheel	Distance of Point of application Below Tread in.	Standard M. C. B. Lb.	Thickened Tread	Ratio Thickened to Standard
158525	0.23	104,700	84,500	0.81
(Flange as cast)	0.23	108,200	97,300	0.90
Average		106,450	90,900	0.85

Only one wheel was tested with metal added in this manner and the results cannot be considered as conclusive. If further investigation should verify these results it would indicate that thickening the tread alone may not strengthen the flange but rather may decrease the lateral pressure required to break the flange and the explanation then could probably be traced to the departure from the "ideal ratio" of flange to tread thickness.

To indicate the effect of increasing both thickness of flange and tread two patterns were prepared with half the circumference having the standard M. C. B. flange and tread and the other half having the flange and tread thickened. In one pattern, represented by wheels No. 158519 and 158518, the thickness of metal added to the flange was 3/16 inches at the extreme back of the flange and this thickness tapered down to zero at the top of the flange. To the tread of this pattern was also added 3/16 inches of metal. In the other pattern represented by wheels No. 158521 and 158520, 3/16 inches of metal were added to thicken the flange and ⅜ inches to the tread. Due to misplaced chillers during moulding the actual ad-

Ultimate Strength of Flange

Wheel No.	Distance of Point of Application Below Tread in.	Standard M. C. B. lb.	Thickened Flange and Tread lb.	Ratio Thickened to Standard
158519	0.41	29,200	31,300	1.07
(Worn Flange)	0.41	32,900	30,000	0.91
158518	0.22	89,400	84,500	0.95
(Flange as cast)	0.22	87,100	91,400	1.05
158521	0.42	32,200	54,800	1.70
(Worn Flange)	0.42	34,000	47,600	1.40
158520	0.22	82,300	137,700	1.67
(Flange as cast)	0.23	87,100	138,600	1.59

ditions of metal are slightly different from the dimensions here given. Two wheels were cast from each patteren, of which one was tested with the flange as cast and the other had the throat ground to represent a worn wheel. The above table gives the results, and in addition gives the ratio of the ultimate strength of the thickened flange and tread to the ultimate strength of the standard M. C. B. flange and tread.

In the wheels No. 158,519 and 158,518 in which 3/16 inches was added to both flange and tread, there was neither increase nor decrease in the ultimate strength due to the additional metal as is shown by the fact that the ratio of the strength of thickened to standard flange was practically equal to 1 for both the wheel having the worn flanges and also for the wheel with the flange as cast. This seems to further verify the results obtained when thickening the flange and tread separately. It will be recalled that adding 3/16 inches to the flange alone increased the ultimate strength from 10 to 96 per cent while adding 3/16 inches to the tread alone decreased the ultimate strength about 15 per cent. The data given here shows that when 3/16 inches is added to tread and flange simultaneously no change occurs in the strength, and the conclusion might be drawn that the increase in strength that would be expected due to thickening the flange was counteracted by a decrease of approximately equal value through the addition of metal to the tread.

The results of tests made on the other pair of wheels, 158521 and 158520 in which 3/16 inch was added to the flange and ⅜ inch to the tread show that an appreciable increase in the ultimate strength of the flange occurs through the addition of metal in this manner. The ratios as given in the table show a minimum increase in flange strength of 40 per cent while the maximum was 70 per cent.

These increases in strength were obtained by the addition of metal equivalent to approximately 37 lb. or 5.1 per cent when applied to a 725 lb. wheel. These results indicate further that the maximum flange strength of the chilled iron wheel has not yet been attained, but rather that the strength of the flange can be materially increased by the proper placing of additional metal in flange and tread. The data on these four wheels further shows that the ratio of the strength of thickened to standard flange is practically the same for the new and worn flange in each pair of wheels thus indicating that when metal is added simultaneously to both flange and tread, as was done in these wheels, the advantage of the additional metal does not disappear as the wheel approaches the condemning limit through flange wear.

The results of the experiments made to determine the ultimate strength of the flange may, within the limits of these tests, be summarized as follows:

a. When the pressure is applied to wheels with badly worn flanges on a radius midway between the points where two adjacent brackets enter the tread the ultimate strength of the flange is an inverse function of the distance of the point of pressure application from the tread, that is, the greater the distance the smaller the ultimate strength.

b. This inverse relation does not exist in the case of new or slightly worn flanges, neither does it hold when the pressure is applied to either new or worn flanges if the point of pressure application is on the same radius as that on which a bracket enters the tread. Under the latter conditions the bracket in some cases apparently strengthened the flange while in other cases a weakening of the flange was apparent thus indicating a complex supporting effect when the pressure is applied in the bracket region.

c. The addition of 3/16 inches of metal to the back of the present standard flange, as proposed by the Association of Manufacturers of Chilled Car Wheels increased the ability of the flange to withstand side thrusts. The increase was plainly evident in the results of five out of six of the specially prepared wheels, in which one-half of the circumference had the present standard M. C. B. flange and the other half had the proposed additional metal. Although one wheel apparently showed decreased flange strength due to the additional metal, the decrease was probably due to a misplaced chiller during moulding and this fact makes it inadvisable to use the results from this wheel in making direct comparisons. The other five wheels showed increased flange strength due to the additional metal ranging from 10 to 90 per cent in the case of badly worn flanges and from 26 to 49 per cent in the case of slightly worn or new flanges.

d. In the wheel wherein one-half of the circumference was cast with the standard M. C. B. tread and the other half with the 3/16 inches of additional metal on the inner and under side of the tread the results were negative in that the half with the additional metal showed the lesser ability to withstand side thrust. Although the results of one wheel can not be taken as conclusive, if further tests confirm these results, the data on this wheel indicates the possibility of adding metal in such a way that no advantage accrues toward strengthening the flange and further that a decreased flange strength may actually be the result.

e. The condition mentioned in *d* indicates further that for a definite thickness of either flange or tread there probably exists a relation or ratio between flange and tread thickness which will result in a maximum flange strength for the particular thickness chosen constant. In other words, having found the ideal ratio of tread to flange thickness, say for a given thickness of flange, the addition or subtraction of metal to the tread will not result in increased flange strength but may decrease it.

f. The simultaneous addition of 3/16 inches of metal to the flange and 3/16 inches to the tread did not alter the ability of the flange to withstand side thrust. It will be recalled that 3/16 inches added to the flange alone gave added strength, hence the results given through equal and simultaneous additions of metal to both flange and tread tend to confirm the statement made in *d* that the 3/16 inches added to the tread probably does not increase the ability of the flange to withstand lateral pressure. The addition of 3/16 inches of metal to the flange together with ⅜ inches of metal to the trend resulted in an appreciable increase in the ultimate strength of the flange. The additional metal was equivalent to about 37 pounds or 5.1 per cent of a 725 pound wheel whereas the increased flange strength resulting therefrom ranged from 40 to 70 per cent. A significant fact is that the advantage of the metal added in this manner apparently does not disappear as the wheel approaches the condemning limit on account of flange wear.

g. The results indicate that through proper placing of metal in the tread and flange, the flange strength of the chilled iron wheel can be increased to keep pace with future service requirements.

Government Operation of India Railways

The government of India has decided to take over the operation of the Great Indian Peninsula Railway and the East Indian system when the contracts of these two companies expire in 1925. The government owns these railways but British companies, domiciled in London, have been operating them. Some concern is manifested in Great Britain whether or not the change in operation will react to the disadvantage of the British railway supply industry, which now fills most of the requirements of the Indian railways for rolling stock and materials.

Snap Shots—By the Wanderer

I happened into the hospital of one of the large steel companies some time ago. It was as immaculate in its cleanliness and orderliness as a hospital ought to be and as they usually are. It was hardly an hour since I had had some pretty intimate glimpses and smelled the odors of the homes where the employes lived. Originally comfortable and well arranged, but filthy in the extreme from neglect and careless living. The contrast was great and I asked the matron whether the cleanliness, with which the sick and injured men were surrounded in the hospital, had any permanent influence on their lives after they had been discharged.

She thought it had, at least, for a time, but that a return to their old surroundings also had its influence and that, in the majority of cases, it finally disappeared or dwindled to microscopic proportions. As an evidence of hospital influence, she cited the case of a young Hungarian about 22 years old, who was brought in rather badly hurt. Up to that time he had never had a bath, and so he was scrubbed and brought to as near perfect cleanliness as a human being can be and put between fresh white sheets. It was a novel sensation and he liked it; liked it so well in fact that when he was able to be up and about he wanted to take three baths a day. It was a simple example of the results of environment.

There was a railroad running through a great summer resort, where every year there was held a floral festival. In order that it might participate in this festival, which contributed quite extensively to its revenues, the railroad established greenhouses at several points along its line. These were put under the care of a skilled gardner, and for the cultivation of flowers other than those of the purely greenhouse variety, beds were planted near the shops, and, to avoid the sharp contrast between a bed of flowers and the cinder-covered surroundings, lawns were developed until these oases in the midst of otherwise dull surroundings became veritable beauty spots. Then flowers began to appear in the shops, on the foremen's desks, on lathes and planer heads, and it is the testimony of the superintendent of motive power that the flowers and lawn next the shop and back of the roundhouse had a decided influence on the tidiness of the men and the attention which they paid to personal appearance.

A hungry and dirty man is apt to be an ill-natured one. Ill-nature makes him a ready listener to any tearing down propaganda that may be offered him. He is ready to believe ill of anything and everything, of anybody and everybody. If an agitator tells him that he is being imposed upon and robbed, he will believe it more readily if he is hungry and dirty than if he has had a hearty meal and is clean.

Railroad managements cannot yet control the food that their men eat or the manner of its preparation, and can only regret the truth of the adage that God sends meat and the devil sends cooks. But they can see to it that, so long as the men are on company property, they are in the midst of tidy surroundings. To those who remember the old-time roundhouse and shop whose only method of lighting was the wick torch, with its smoke-producing capabilities, the modern shop and roundhouse with their approved methods of ventilation, the change from then to now, marks a new era in care and management.

It is an old saying of the gambler that things can never be so good that improvement is impossible. So, while we have made great strides in shop comfort, there is still room for changes for the better. Men may be dirty or get dirty in their work, but the effect of cleanliness about them has an uplifting effect, and the influence for good and improvement in morale and loyalty to the company of clean surroundings are very great. For example, at a certain shop restaurant the counter was kept scrubbed until the boards fairly shone. The floor was swept and the coffee urns were bright. But the cutlery frequently had a greasy feel; the hands and nails of the servers were dirty and their aprons were a sight to behold. The men came to the counter with hands in the same condition in which they were when they left their work, and the table conversation consisted mostly of abuse of the company.

It so happened that the general superintendent tried to lunch there one day, but the servers' condition took his appetite away.

Then came a change; their hands were cleaned and fresh aprons were put on as soon as any soil appeared. It was not much of a change and nothing was said about it. But gradually the men came to lunch with clean hands, and the table talk drifted away from abuse of the company to other common topics.

If surface indications mean anything, the use of an unobtrusive cleanliness would seem to be a very good means of improving morale and developing the loyalty of employes.

Railroad managers are seeing the light in the matter of publicity. I met with a prompt disagreement on the part of an officer the other day when I ventured to suggest that there were some things that might as well be kept under cover; innocent things; things that involved no wrongdoing whatever, but which, if made public, no matter how fully and honestly, would be picked up and distorted by the yellow journals, and the public be led to believe that they were being robbed. His gospel was to tell the truth and the whole truth, regardless of whom it praised or blamed.

He was a claim agent for a great railroad in a city of about 60,000 or 70,000 inhabitants. The papers of the city, one of which was very influential throughout the surrounding territory, were continually pounding the railroad in season and out to the great annoyance of its officials and to the detriment of the loyalty of the men which such things were gradually undermining.

It was the policy to sit tight, say nothing, give out no information and let them guess, with the result that they always guessed things to be far worse than they could be.

He asked, and finally received, permission to handle the situation in his own way for six months, on the promise that he would show results.

His first and only move was to tell all he knew about everything that happened, regardless of who was hit. The blame was put on the railroad if it belonged there. The newspaper men were quick to recognize the honesty and reliability of the information furnished them and that man's office soon became the mecca for every reporter in search of railroad news. He was looked upon as the true source of what they wanted, and if things happened at night they would rout him out of bed and ask him to get the correct news and set them straight. Of course, the abuse stopped, and editorial comments on railroad happenings were moderate and fair. And all because one subordinate officer had the courage to tell the truth and the whole truth, regardless of consequences. Human nature does not differ or change greatly. To ask a man how the world treats him is to ask him how he treats the world. And if railroad officers consistently tell the truth they will get far better treatment than if they try a policy of concealment and secrecy.

Such was the philosophy of my friend and his experience led me willingly and easily to believe that he is right.

The Development and Importance of Power Brakes in Transportation

A Review of Experience in the United States and the Present Situation in India Indicates that History Repeats Itself—The Value of Brakes in the Controlling Factors of Transportation

By W. E. SYMONS

In the history of railway development, many complex problems confronted the officers. One of the most difficult was the question of an adequate system of brakes whereby moving trains could at the proper time and place be brought to a state of rest.

Originally, all braking both passenger and freight was by hand. The station whistle sounded by the engineer was also the signal or call for the brakeman to set up hand brakes to stop the train and in case of emergency or danger at or between stations all the engineer could do was to whistle for the brakes to be applied by hand, he being without means to aid, other than reversing his engine which was not infrequently resorted to when in close quarters.

In 1869, the Westinghouse non-automatic air brake, which has since generally been designated as the "Straight Air" brake, was brought out and first applied to a train on the Pennsylvania R. R. It consisted of a very simple-actuated air pump placed upon the side of the engine, and a reservoir in which the compressed air could be stored. A pipe line from the reservoir was carried throughout the length of the train, connections between vehicles being made by means of hose and couplings. Each vehicle was provided with a simple cast-iron cylinder, the piston rod of which was connected to the brake rigging in such a way that when the air was admitted to the cylinder the piston was forced out and the brakes thereby applied. In the engineer's cab there was placed in the pipe line just mentioned a three-way cock, by means of which compressed air could be admitted to the train-pipe and thus to the cylinders on each car; or the air already in the cylinders and train-pipe could be discharged to the atmosphere, thus releasing the brakes. This was the simplest and most efficient brake that had been introduced up to that time and was largely adopted by the American railways; but while all that could be desired for single vehicles, the danger incident to the entire loss of braking power when most needed, due to the bursting of hose under pressure, the parting of the train or other rupture of the brake system led to the invention of the automatic brake by Mr. George Westinghouse, probably the greatest advance step ever made in the development of the art. The first form of this brake was introduced in 1872, and is now generally referred to as the "plain automatic." The essential difference between this brake and the straight-air type which it promptly superseded consisted in the installation of supplementary or auxiliary reservoirs for the storage of compressed air on the cars in addition to the main reservoir on the locomotive, so that each vehicle carried its own supply, and the employment of a most ingenious valve mechanism which the application of the brake was caused by the reduction of air pressure in the train-pipe, whether such reduction was made intentionally or as the result of accident. The device by means of which this arrangement was made possible was called a "triple brake," because of its three-fold function of applying the brake, releasing it, recharging the auxiliary reservoir. In this triple valve was slide valve attached to a piston, so placed that train-pipe pressure was always on one side of it and auxiliary reservoir pressure on the other. When train-pipe pressure exceeded auxiliary reservoir pressure the piston and slide valve took such position that air could flow from the train-pipe into auxiliary reservoir, at the same time opening a port leading from the brake cylinder to the atmosphere; if the train-pipe pressure was reduced below that of the auxiliary reservoir, the piston and slide valve moved to another position in which air could flow from the auxiliary reservoir into the brake cylinder and apply the brakes. The operation of the brakes throughout the train was thus under the entire control of the engineer through the medium of train-pipe pressure actuating the triple valve on each vehicle. A reduction of train-pipe pressure applied the brakes, while the restoration of normal pressure by allowing air to flow from the main reservoir into the train-pipe released them.

The three-way cock in the engineer's cab was replaced by a more elaborate valve known as an engineer's brake valve. The necessity for this substitution was due to the fact that in applying the brakes the reduction of pressure in the train-pipe had to be more carefully made than was practicable with an ordinary three-way cock. This brake valve was arranged so that in releasing the brakes, air was allowed to flow from the main reservoir on the engine into the train-pipe and auxiliary reservoirs. The engineer by moving the handle to the application position connected the train-pipe to the atmophere through very carefully graduated openings and the pressure gauge connected to the train-pipe showed how much reduction was made, and indicated, therefore, the amount of air that would flow from the auxiliary reservoirs into the brake cylinders. As the discharge to the atmosphere from the train-pipe was slow, the pressure of the latter decreased throughout its entire length almost uniformly, and, as a consequence, the brakes were applied throughout the train with practically equal force and in about the same time. Thus the difficulty with straight air was overcome and the new conditions then existing were fully met.

In the same year, 1872, the Smith vacuum brake appeared. This apparatus consisted of two collapsible cylinders on each vehicle, connected between vehicles as in the compressed air brake. An "ejector" was installed on the locomotive, by means of which the air in the train-pipes and brake cylinders was exhausted and the brakes applied through the contraction of the cylinders with which the brake levers were connected. The greater safety and efficiency of the automatic air brake was demonstrated so early that with a very few exceptions the plain vacuum brake soon passed out of service in the United States. For the same reasons the automatic vacuum, a later invention, was never adopted to any extent outside of England.

The immense advantage to railway companies along the line of higher speed, greater safety, and pronounced economy in the substitution of a reliable automatic power brake under the control of the engineer for the old hand brake was soon recognized and the work of making this change proceeded rapidly throughout the entire country. Naturally enough, the new conditions encountered brought to light new problems, the solution of which enlisted the best efforts of railway officials and brake manufacturers alike.

During the foregoing period there was a constantly increasing number of men of an inventive turn of mind who believed railway trains should be controlled by the engineer in stopping as well as starting and running, and that a complete continuous train brake to be located in the engine cab should be designed and installed, notwithstanding many of the less progressive railroad men seemed to think the old hand brake was, and would continue to be the last word for stopping trains.

At the annual meeting of American Railway Master Mechanic's Association in Baltimore, May 1873, just 50 years ago, there was a report on continuous train brakes and on compression brakes, from which it would appear that in response to a questionnaire, thirteen out of twenty-four roads reported they were using the Westinghouse brake, while eleven or about 45 per cent were using the old hand brake. One road had used a steam brake (the Goodall), but dropped it as unsatisfactory. Mr. Peddle, S. M. P., T. H. I. R. R., father of C. R. Peddle, now Purchasing Agent for that line, used in competition with Westinghouse, a brake of his own invention, and in the operation of which it was necessary to reverse the engine, thus making air pumps of the engine cylinders, and although his brake cost only half as much as the Westinghouse he soon dropped it.

The P. F. W. & C., Pennsylvania R. R. reported, that with hand brakes on passenger trains there were in one year eighty-one pairs of wheels removed at a net cost of $4,078.50, while with Westinghouse compressed air brakes over a similar period, there were only thirty-six removals at a cost of only $608.40 or a saving of $3,-470.10. The power brakes in use and reported at this time were, Smith's American Vacuum, Goodall Steam, Myers & Wards, The Electric & Steinard. The trend of thought, however was drifting toward the compressed air brake.

Master Mechanics Conventions at Chicago, May, 1874

At the Master Mechanics meeting one year later, of twenty different roads responding to a general questionnaire, only three roads were still using hand brakes on passenger trains, one the Creamer brake, two Smith Vacuum, and fourteen Westinghouse, which latter design up to that time had been applied to the following equipment on 141 different railroads:

Locomotive	2,232
Passenger Cars	6,900

With 66 locomotives and 448 cars on sixteen different roads in England, Scotland, Belgium, South America, Cuba and Mexico.

Other competitors had now entered the field for air brake honors, Gardiner and Ransom, and the Loubridge air brake, were with the Smith Vacuum the principal ones, and during the next 25 to 30 years, or up to 1905, it would be difficult to enumerate all the different designs and systems patented, quite a few of which have been given rather extended trials, but none of these have so far, in this country, been standardized, while most of them have long since passed into history.

Situation in Foreign Countries

The situation abroad is somewhat different although it must be berne in mind that operating conditions there, are unlike ours. In that country, both freight and passenger trains are as a rule lighter in weight, shorter in length, and particularly their freight cars, or "goods wagons," are many of them too light for power brakes of any kind.

Our English cousins, who have developed some of the finest railway equipment extant, and who have had equal opportunity with us to observe and determine the relative merits of power brakes, are using largely as their standard the Vacuum brake which clearly did not measure up to our requirements, and in this respect, it is thought by many careful observers in different parts of the world that they have not made the same degree of progress attained in other matters.

English standards generally obtain also in their colonies and it would no doubt be interesting to learn from an international traveler, what beautiful freight trains he saw in India and how correspondingly inefficient were the power brakes.

The situation can best be understood by reading his report submitted in this country but drawn from personal observation while traveling in India, and from this it would seem there was an excellent opportunity for our English railroad friends to profit by our experience in the matter of power brakes.

The Vacuum Brake in India

By an International Traveler

The Government of India having intimated their intention to shortly insist upon all freight trains on the broad gauge railways having continuous brakes in operation throughout, the British officials on the different lines are up against a very serious proposition. The automatic vacuum brake was adopted many years ago for the passenger equipment of the Indian railways, and when the desirability of fitting the freight stock was brought forward some 15 or 16 years back the vacuum apparatus was accepted as being more or less a necessity owing to its existence on the passenger cars. Locomotives and cars have now been in process of fitment for more than 16 years, and some $30,000,000 have been spent on the apparatus, and at the present moment quite two-thirds of the entire freight equipment is fitted with vacuum brake apparatus. The balance of the cars are to be "piped" as early as possible, and it was expected to get the brake apparatus into full working order by the 1st of April 1923 (i. e. the commencement of the next financial year), but now the 1st of April 1924 is the date fixed.

As no attempt was made by the brake manufacturing companies to impress upon the railway administrations the necessity of getting the apparatus to work as it was put into service, or in other words directing that "pipes" should be provided on all vehicles at the onset so that the brake apparatus could be coupled up of any vehicles presenting, the railways neglected this duty, with the consequence that thousands of cars have been fitted with brake apparatus, which has never been used and consequently fallen into a hopeless condition of unserviceability. The great difficulty now is to renovate and put into working order the brake apparatus of this vast collection of rolling stock. When it is remembered how much the vacuum brake depends on rubber details for its successful working, it is not difficult to imagine the condition the apparatus is found in when examined on vehicles which have been running for years with the brake apparatus never used. With the vacuum brake for ordinary goods wagons, the piston which provides the power for the application of the brake relies on a "rolling" rubber ring for airtightness in its passage up and down the cylinder. Needless to say this is a very troublesome detail to keep in good order in a tropical country like India. Then there is the gland for the piston rod, the pipe for connecting the brake cylinder with the train pipe, etc. All these are of rubber and all give trouble in service.

In the operation of trial trains, which the different administrations have been making efforts to work, so as to be prepared for the eventful 1st of April 1924, considerable difficulty has been found in maintaining vacuum on the long trains now common representing 1,500 to 2,000 feet of "pipe." Vacuum is created and maintained by an ejector wherein boiler steam escapes from suitable cones, and induces air from the brake-pipe and maintains partial exhaustion to a degree equivalent to say 20" of mercury or the equivalent of ten pounds pressure. The amount of steam required for the purpose is out of all proportion to the power obtained.

Further, leaks are most difficult to detect in the system. This is not to be wondered at when we consider that the inspection has to be made in yards where considerable amount of marshaling, etc., is going on. It is difficult to always hear the "hiss" of escaping air from the air brake system in use in this country, but how much more troublesome is it to detect the feeble noise of a vacuum leak in the pipes of trains inspected under such conditions.

Then again the vacuum brake apparatus is large and awkward to manipulate. What would the mechanical department of an American railroad say to having to take down the whole cylinder when defective and replace it with a repaired one as the easiest and most convenient method of correcting a fault, and yet this is what has to be done in India. The men pride themselves in being able to take down and replace a cylinder complete in 15 minutes. The repaired cylinders, it might be remarked are tested and kept in a rack awaiting use on trains. Next the apparatus is very prone to suffer from loss by theft, it is easily pulled apart, the vacuum connections are simply clipped on. The hose pipes for couplings being each 2 inch internal diameter and about 2 feet, 3 or 4 inches long, make a very convenient receptacle for carrying water, and thousands are taken off the vehicles to be used for this purpose.

Next comes the difficulty of releasing the brakes. On long trains, the amount of air that has to be moved is very considerable and to recreate vacuum on a train of forty cars often takes more than three minutes, that is when all the apparatus is tight and in good order. The great trouble in India at present is the bad condition the brake apparatus is found in, not having been used but neglected and abused. On a recent occasion a train of sixty-four vehicles was formed on a certain division of the State Railways, consisting entirely of fully fitted wagons. When this train came to be examined at the depot station only fourteen of the sixty-four could be put into working order by the usual running staff. Even then a considerable amount of rubber, etc., had to be used to get these few wagons tight and in good order.

A serious defect in the vacuum apparatus is that, being a device operating by balance as it were, there is no reserve of power. Consequently on steep inclines if the engineer finds his speed increasing after a full application, he cannot reproduce power without releasing all the brakes. Hence it is customary on trains operated with the vacuum brake to still continue the old-fashioned method of "pinning" dowo the hand brakes on a number of cars to ensure control of the train. Such a system of working entails an enormous amount of damage to draw-gear, etc., whilst hauling the trains on to the grades. Another defect due to the same principle in operation of the brakes, precludes any use of the power brake on vehicles that have been detached from a train, so that in gravity yards during marshaling, etc., no use can be made of the brake apparatus.

We in America tried the vacuum brake years ago, and although some very promising systems were used, and much money and brains were devoted to it, we came to the conclusion that it would not compare with the air system for the wants of modern traffic, and so far as we can see our expectations have been fulfilled. India will be the first large railway system to put the vacuum brake to a real and critical test and very considerable interest will be attached to what we shall see happening in that country during the next 12 months or so. The railwaymen themselves are very pessimistic, and only recently at a conference at which all the leading railways were represented by their mechanical officers, very serious doubts were raised as to the possibility of securing satisfactory operation of the vacuum brakes on long goods trains.

Value of Power Brakes in Transportation

From the foregoing observations of a well known authority on railroad problems of this character, and who has been to India and secured first hand information on the subject, it appears that the same mistaken experiment is about to be tried there, and at great expense to the railroads, that was attempted here, and while we as engineers and railroadmen command the principle of patronizing home industry to the limit of good business judgment, we know from experience the experiment will fail, and "history will repeat itself," for nature's laws have not to our knowledge yet been transcended, and will not be in this instance.

The comparative value and relative importance of the air brakes on the railways of the United States is little understood or appreciated by the average citizen or traveler, and by few railroad men, and in order to emphasize this point the fundamentals may be cast up for comparative purposes.

That the steam and electrice locomotives have annihilated space we all agree, but few realize that were it not for the fact that brakes have also kept pace with this development, all our high powered and high speed engines would be of no avail, and that our advance from the conditions of 40 to 50 years ago *has* and *is* as much dependent on our ability to hold and stop trains as to accelerate them to high speeds with powerful modern engines.

Let us cast up some of the more important statistical facts for consideration:

ITEMS	AMOUNTS
Mileage	250,649
Capitalization	$19,003,045,429
Locomotives	66,721
Passenger cars	55,781
Freight cars	2,380,950
Passengers carried one mile	47,276,131,000
Tons freight " " "	411,151,320,000
Total earnings	$6,355,284,000
" " per day	$17,685,708
Total trains	15,000,000
" " per day	41,000
Value of locomotives (@ $40,000)	$2,668,840,000
Value of all brakes (2,503,452 sets)	$273,000,000
Per cent of value of locomotives	10.23%
" " " " " entire property	01.4 %

During the past year there were 5,996 persons killed on railways of United States, 2,481 of whom were trespassers. There were 273 accidents to locomotives in this same period involving loss of life or injury to person, and only 34 of these, which cover 66,721 locomotive equipments, were charged to brakes and rigging, while during this same period there were at times as many as 300,000 freight cars and 18,000 locomotives out of commission awaiting repairs, for causes other than brakes.

It may safely be said without fear of successful contradiction that no part of the physical property of our railways is of as great importance and cost as little in proportion thereto, as the system of brakes without which the foregoing results from operation would not be possible.

102,912 New Freight Cars on Order

From January 1, 1923, to March 1, 25,866 new freight cars were placed in actual service on the railroads, while orders calling for the delivery of 102,912 additional cars had been placed, according to the Car Service Division of the American Railway Association. More new equipment is now on order than ever before at this time of year in the history of the railroads.

From January 1 to March 1 the railroads also placed in service 589 new locomotives, while on March 1 reports showed 1,945 new locomotives on order.

Of the 25,866 new freight cars placed in service up to March 1, 11,319 were box cars, 9,717 were coal cars, and 1,748 were railroad-owned refrigerator cars. The total number of new cars installed in service included 1,334 new refrigerator cars.

Of the 102,912 new freight cars on order on March 1, 49,220 were box cars; 35,989, coal cars, and 4,012 railroad-owned refrigerator cars, as well as many other classes of freight car equipment, while private refrigerator companies had on order 9,147 refrigerator cars.

Locomotives

The Grand Trunk has ordered five 0-8-0 type switching locomotives from the Lima Locomotive Works.

The Kentucky & Indiana Terminal has ordered five 0-8-0 type switching locomotives from the Lima Locomotive Works.

The New York, New Haven & Hartford has ordered 10 Mountain type and five switching locomotives from the American Locomotive Company.

The Elgin, Joliet & Eastern has ordered five Mikado type locomotives from the Lima Locomotive Works.

The Louisville & Nashville has ordered 30 Mikado type and six Pacific type locomotives from the American Locomotive Company.

The Litchfield & Madison Railway has ordered three locomotives from the American Locomotive Company.

The Baltimore & Ohio has ordered 75 additional locomotives of the 2-10-2 type, 25 from the Lima Locomotive Works and 50 from the Baldwin Locomotive Works.

The Wisconsin & Arkansas has ordered one Mogul type locomotive from the Baldwin Locomotive Works.

The Ann Arbor has ordered three Mikado type locomotives from the American Locomotive Company.

The Ford Motor Company has ordered four 0-8-0 switching locomotives from the Lima Locomotive Works.

The Sibomook Lake & St. John has ordered one Prairie type locomotive from the Baldwin Locomotive Works.

The Chicago, Wilmington & Franklin Coal Company has ordered one 0-6-0 type locomotive from the Baldwin Locomotive Works.

The Philadelphia Electric has ordered one locomotive from the Baldwin Locomotive Works.

The Boston & Maine has ordered 10 2-10-2 type locomotives and 10 Pacific type locomotives from the American Locomotive Company.

The Akron, Canton & Youngstown has ordered three Consolidation type locomotives from the Baldwin Locomotive Works.

The Seaboard Air Line has ordered 20 Mikado type locomotives from the American Locomotive Works.

The Chilean State Railways has ordered 25 locomotives from the Baldwin Locomotive Works.

The Pennsylvania Railroad is reported to have placed an order for repairs to 500 locomotives with the Baldwin Locomotive Works.

The Toledo Terminal has ordered two Consolidation type locomotives from the American Locomotive Company.

The New Jersey Zinc Company has ordered one Mogul type locomotive from the Baldwin Locomotive Works.

The Mississippi Central has ordered two Mikado type locomotives from the American Locomotive Company.

The Detroit Edison Company has ordered one 0-6-0 type locomotive from the Baldwin Locomotive Works.

The Atlanta & West Point has ordered three Mikado type locomotives from the Lima Locomotive Works.

The Carolina Clinchfield & Ohio has ordered 10 Mikado type locomotives and 12 Mallet type locomotives from the American Locomotive Company.

Freight Cars

The Erie has ordered 1,000 box cars from the Pressed Steel Car Company; 1,000 box cars and 1,000 gondola cars from the Standard Steel Car Company, and 1,000 gondola cars from the Youngstown Steel Car Company.

The Philadelphia Electric Company has ordered seven hopper cars of 55 tons' capacity from the Pressed Steel Car Company.

The Universal Portland Cement Company has ordered 300 all-steel box cars from the American Car & Foundry Company.

The Chicago & North Western has ordered 40 10,000-gal. capacity tank cars from the American Car & Foundry Company.

The White Eagle Oil & Refining Company, Wichita, Kan., has ordered 100 8,000-gal. capacity tank cars from the Pennsylvania Tank Car Company.

The Hillman Coal & Coke Company has ordered 300 hopper cars of 70 tons' capacity from the Pressed Steel Car Company.

The Illinois Central has ordered 1,000 automobile cars from the American Car & Foundry Company, 500 automobile cars from the Western Steel Car & Foundry Company, and 500 automobile cars from the Mt. Vernon Car Manufacturing Company.

The Buffalo & Susquehanna has ordered 200 all-steel hopper car bodies of 55 tons' capacity from the Buffalo Steel Car Company.

The Louisville & Nashville has ordered 6,000 hopper cars of 55 tons' capacity from the Pressed Steel Car Company, 1,000 ventilated box cars of 40 tons' capacity from the Mt. Vernon Car Manufacturing Company, and 1,000 ventilated box cars of 40 tons' capacity from the Chicksaw Shipbuilding Company.

The Gulf Refining Company has ordered 50 tank cars from the Standard Steel Car Company.

The Seaboard Air Line has ordered 1,000 box cars from the Pressed Steel Car Company, 800 gondola cars from the Standard Steel Car Company, and 200 gondola cars from the Newport News Shipbuilding Corporation.

The Toledo, St. Louis & Western is inquiring for 100 flat cars of 50 tons' capacity.

The Southern Pacific is inquiring for 300 50-ton work cars.

The Skelly Oil Company has ordered 50 8,000-gal. capacity tank cars from the Standard Tank Car Company.

The Southern Railway has ordered 200 stock cars from the Kilby Car & Foundry Company.

The Montana, Wyoming & Southern has ordered 25 freight cars from the Mt. Vernon Car Manufacturing Company.

The Republic Iron & Steel Company has ordered 50 flat-bottom gondola cars from the Standard Steel Car Company.

The Fruit Growers Express is reported to have ordered 1,000 steel underframes from the Pressed Steel Car Company and 1,000 from the Standard Steel Car Company.

The Southern Railway has ordered 2,000 coal cars from the Lenoir Car Works.

The Chesapeake & Ohio has ordered 1,000 hopper cars of 70 tons.

The New York Central has ordered 1,500 hopper cars and 500 box cars from the Standard Steel Car Company, 1,500 box cars from the American Car & Foundry Company, and 500 hopper cars from the Pressed Steel Car Company.

The New York Central has ordered 100 Hart convertible ballast cars of 50 tons' capacity from the American Car & Foundry Company.

The Chicago & Illinois Midland Railroad is inquiring for 500 gondola car bodies.

The Louisiana Railway & Navigation Company is inquiring for 300 30 ton box cars.

The Stone & Webster Engineering Corporation has ordered two hopper cars of 55 tons' capacity from the Pressed Steel Car Company.

The Missouri Pacific has ordered repairs to 1,500 box cars from the Springfield Car & Equipment Company.

Texas Company has ordered 200 tank cars from the Pennsylvania Tank Car Company, 50 tank cars from the Chicago Steel Car Company, and 50 tank cars from the Standard Tank Car Company.

The Sun Oil Company has ordered 150 tank cars from the Standard Tank Car Company.

The Atlantic Coast Line is inquiring for 500 gondola cars and 50 steel underframes for caboose cars.

The Canadian Pacific is inquiring for 1,000 box cars of 40 tons' capacity.

Illinois Central is contemplating repairs to several thousand freight cars.

Powers & Quinlan, Tulsa, Okla., has ordered six tank cars from the Standard Tank Car Company.

The Virginian Railway is inquiring for 1,000 gondola cars of 120 tons' capacity and 500 hopper cars of 70 tons' capacity.

The Seaboard Air Line is inquiring for 25 caboose cars.

The Missouri Pacific has ordered repairs to 1,500 box cars from the Springfield Car & Equipment Company and repairs to 600 coal cars from the Mt. Vernon Car Manufacturing Company.

Passenger Cars

The Atlantic Coast Line is inquiring for 25 74-ft. steel coaches, 15 70 ft. steel baggage and express cars, also five 70-ft. combination mail and baggage cars.

The New York Central has ordered 25 steel coaches from the Osgood-Bradley Car Company and 10 milk cars from the Merchants Despatch Transportation Company.

The Illinois Central is inquiring for four parlor cars, two cafe lounge cars, five dining cars and eight baggage cars.

The Chicago & Illinois Midland is inquiring for 50 miscellaneous passenger cars.

The Missouri-Pacific is inquiring for five mail storage cars and 10 baggage cars.

The Hudson & Manhattan Railroad has ordered 25 bodies and trucks for motor passenger cars from the American Car & Foundry Company.

The Delaware, Lackawanna & Western is inquiring for 10 express milk cars.

The Southern Railway has ordered five dining cars from the Pullman Company.

The Pullman Company is building 100 sleeping cars in its own shops.

The Southern Pacific has ordered five 60-ft. chair cars, five 60-ft. coaches, 15 72-ft. coaches, 15 70-ft. baggage cars, one 72-ft. 6-in. combination coach and baggage car from the American Car & Foundry Company.

Buildings and Structures

The Chicago & Northwestern contemplates the construction of a roundhouse and repair shop at Watersmeet, Mich.

The El Paso and Southwestern will extend and improve the roundhouse and coach shop facilities at El Paso, Tex.

The Chicago, Burlington & Quincy is receiving bids for a five-stall addition to its roundhouse at Eola, Ill., and a seven-stall addition to its roundhouse at Aurora, Ill.

The Texas & Pacific contemplates the expenditure of about $1,000,000 for shop and terminal facilities at Alexandria, La.

The Chicago, Rock Island & Pacific is receiving bids for the construction of an eight-stall roundhouse at Haleyville, Okla.

The Maine Central has completed plans and will soon award contracts for the construction of a modern locomotive terminal, including a roundhouse with capacity for 40 locomotives at Rigby, South Portland, Me.

The Duluth & Iron Range has awarded a contract to the Roberts & Schaefer Company, Chicago, for the construction of a 2,000-ton capacity reinforced concrete, automatic electric coaling station at Two Harbors, Minn.

The Atchison, Topeka & Santa Fe will construct a water-treating plant at Hot Springs Junction, Ariz.

The Central of Georgia has awarded a contract to the Ogle Construction Company, Chicago, for a concrete, electrically-operated coaling station, which will provide for ground and overhead storage of 9,000 tons and 600 tons of coal, respectively, and the storage of 235 tons of sand at Macon, Ga.

Supply Trade News

A. A. Taylor, formerly manager of the railroad division of Fairbanks, Morse & Company of Chicago, has been elected vice-president and general manager of the **Locomotive Firebox Company**, manufacturer of the Nicholson Thermic Syphon. Mr. Taylor entered railway service in 1887, and in 1889 was engaged in the stoker department of Westinghouse Church, Kerr & Company of Chicago. In 1891, he entered the sales department of the Morden Frog & Crossing Company, Chicago, and in 1899 entered the railroad sales division of the Fairbanks, Morse Company of which he became manager in 1915, in charge of both domestic and foreign railway sales and served in this capacity until he resigned. Mr. Taylor was active in railway supply association work and served as a director of the National Railway Appliance Association.

E. M. Speakman, formerly machine shop foreman of the Virginian Railway, and **B. O. Yearwood**, formerly chief inspector of the United States Railroad Administration at the Richmond Works of the American Locomotive Company, are now in the employ of the **Franklin Railway Supply Company, Inc.**, New York, as inspectors at builders' plants.

Charles D. Jenks has resigned as president of the Damascus Brake Beam Company, Cleveland, and has been appointed vice-president of the **Chicago, Cleveland Car Roofing Company**, with headquarters at Chicago. Mr. Jenks entered railroad service with the Pennsylvania and spent nine years in the freight and operating departments at Philadelphia. He resigned to enter the employ of the Atlantic Refining Company, in the engineering and construction department. In 1900 he became vice-president of the Pressed Steel Car Company, and in 1910 became sales agent of the company at Chicago, which position he held until 1910, when he became western sales manager of the Standard Coupler Company. In 1912 he became general manager of the Edwin S. Woods Company, and in 1918 was elected president and general manager of the Damascus Brake Beam Company.

A. M. Meston has been appointed service engineer of the Pacific Coast for the **Franklin Railway Supply Co., Inc.** Mr. Meston was for twenty-five years with the Southern Pacific Railroad. He fired and ran a locomotive on the Tucson division from 1898 to 1905. He resigned from his division to become an engineer on the Sacramento division, being subsequently promoted to asistant road foreman of engines on that division. From there he was sent to Bakersfield where he spent twenty-one months as road foreman of engines on the Thachapi Mountains. His next promotion was to assistant general air brake inspector of the Southern district of the Southern Pacific, a position he filled for four years, when he was made district road foreman of engines, the position which he held at the time he resigned to join the Franklin Railway Supply Company, Inc.

Items of Personal Interest

J. Hainen, assistant to the vice-president, mechanical, of the Southern, with headquarters at Washington, D. C., has resigned.

James J. Bigger has been appointed road foreman of engines of the Idaho Division of the Northern Pacific, with headquarters at Parkwater, Idaho. Mr. Biggers joined the Northern Pacific forces in 1892 as steam shovel fireman and craneman. He was a locomotive fireman on the Idaho division from 1894 to 1897; serving as steam shovel engineer from 1897 to 1900 and as locomotive engineer on the Idaho division from 1900 to 1923.

J. W. Senger, master carbuilder of the New York Central at Collingwood, Ohio, has been promoted to superintendent of rolling stock of the lines west of Buffalo, with headquarters at Cleveland, Ohio.

T. C. Baldwin has been appointed master mechanic of the New York, Chicago & St. Louis, with headquarters at Stony Island, Ill.

J. C. Garden has been appointed general superintendent of motive power of the Canadian National, and **C. E. Brooks** has been made chief of motive power, and **W. E. Barnes** has been appointed superintendent of motive power of the same road.

P. W. Kiefer, formerly assistant engineer in the mechanical department of the New York Central, has been appointed assistant engineer of rolling stock, with headquarters at New York.

Charles S. Branch has been appointed master mechanic of the Chicago & Alton, with headquarters at Bloomington, Ill. Mr. Branch was formerly superintendent of the Chicago, Peoria & St. Louis.

W. G. Black has been appointed superintendent of motive power of the New York, Chicago & St. Louis, with headquarters at Cleveland, Ohio.

G. E. Smart, mechanical assistant in the car department of the Canadian National, at Moncton, N. B., Can., has been appointed superintendent of car equipment of the Atlantic Region, with headquarters at the same point.

J. Coleman, assistant to the general superintendent of the motive power and car departments of the Grand Trunk Lines, east of Detroit, has been appointed general superintendent of the car department of the Canadian National, Central Region, with headquarters at Toronto, Ont., Can.

C. F. Needham, assistant to the general superintendent of the motive power and car departments of the Grand Trunk, has been appointed assistant to the general manager of the Central Region of the Canadian National, with headquarters at Toronto, Ont., Can.

E. M. Sweetman, superintendent of motive power of the Southern, lines west, with headquarters at Cincinnati, Ohio, has been transferred in a similar capacity to the lines east, with headquarters at Charlotte, N. C., succeeding W. F. Kaderly, resigned.

A. G. Akans, road foreman of engines of the Southern, with headquarters at Sheffield, Ala., has been transferred to Knoxville, Tenn., succeeding G. G. Shafer, who has resigned.

Frank Johnson, master mechanic of the Southern at Ferguson, Ky., has been appointed superintendent of motive power of the lines west, with headquarters at Cincinnati, Ohio.

Obituary

William S. Carter, formerly president of the Brotherhood of Locomotive Firemen and Enginemen, died March 15, at Baltimore, Md. He had been in ill health for several years. He was 63 years old, having been born in Austin, Texas, August 11, 1859. Mr. Carter had devoted his whole life to or-organization of the brotherhood of locomotive firemen and enginemen. He was president of the union for a number of years.

Mr. Carter became a railroad man when 20 years of age and worked as a fireman and engineer for 15 years on several southwestern roads and in Mexico. He later became editor and manager of the locomotive firemen and enginemen's magazine, official organ of the brotherhood.

In 1904, Mr. Carter was elected general secretary and treasurer of the Brotherhood of Locomotive Firemen and Enginemen, serving until 1908, when he became president. He held that office for 14 years.

William G. McAdoo, when secretary of the treasury and director general of the United States Railroad Administration, appointed Mr. Carter as director of the division of labor in the administration. He served as labor director from 1918 until 1920, in addition to his duties as president of the brotherhood. He later was succeeded as president by D. B. Robertson and became manager of the research department of the union, which office he held at the time of his death.

R. E. Janney, consulting engineer of the coupler department of the American Steel Foundries, Chicago, died on March 2 in Chicago.

Columbus K. Lassiter, president of the Consolidated Machine Tool Corporation of America, and formerly vice-president of the American Locomotive Company in charge of manufacturing, died suddenly in New York on March 3.

Books, Catalogues, Etc.

Properties of Chilled Iron Car Wheels

Bulletin No. 135, "An Investigation of the Properties of Chilled Iron Car Wheels. Part III. Strains Due to Brake Application. Coefficient Friction and Brake-Shoe Wear," by J. M. Snodgrass and F. H. Guldner, is the third and final report of the investigation of the properties of chilled iron car wheels, which was carried on under coöperative agreement between the Association of Manufacturers of Chilled Car Wheels and the Engineering Experiment Station of the University of Illinois.

As may be gathered from its title, Bulletin No. 135 deals first with strains due to brake application, and second, with the coefficient of friction betwen the wheel and the brake-shoe, and the brake-shoe wear. Six chilled iron wheels and one forged steel wheel were used in the test to determine the strains produced through the application of brakes under the nominal conditions of speed, brake-shoe pressure, and length of run. In these tests data were secured for the determination of the coefficient of friction, the tangential pull, the work done by the brake shoe on the wheel, and the weight of metal lost by the shoe. In addition, a series of tests was made to ascertain the coefficients of friction and the brake-shoe losses for a chilled iron and a steel wheel under similar conditions of brake-shoe pressure and speed, the shoe pressure ranging from 500 to 3,000 pounds and the speed from 5 to 50 miles per hour.

The Appendix of Bulletin No. 135 describes the determination of linear thermal expansion, for which a formula has been worked out, and the method of determining the temperatures in a rotating car wheel, and contains thirty-two full-page figures giving the results of the brake-application tests.

Copies of Bulletin No. 135 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

Year Book, American Engineering Standards Committee, 1923

The American Engineering Standards Committee is formed of representative members of seventeen technical associations and six government departments, and is intended to serve as a national clearing house for engineering and industrial standardization. Its existence makes possible a systematic plan of co-operation by which it is possible for all interested organizations to participate in the establishment of any particular standard.

The 1923 year book, which is a pamphlet of 48 pages, shows that the national movement for industrial standardization has made more progress during the past year than in any preceding year, so that the projects which have now reached an official status number 120 and cover a wide range of subjects.

The committee is working in close cooperation with the preparation of government standards, and industrial and commercial bodies have shown a greatly increased interest in its work.

Up to the present, however, comparatively little work has been done in connection with steam railway work, though that of the American Electric Railway Association and the Society for Testing Materials is up for consideration in the form of a number of their specifications.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

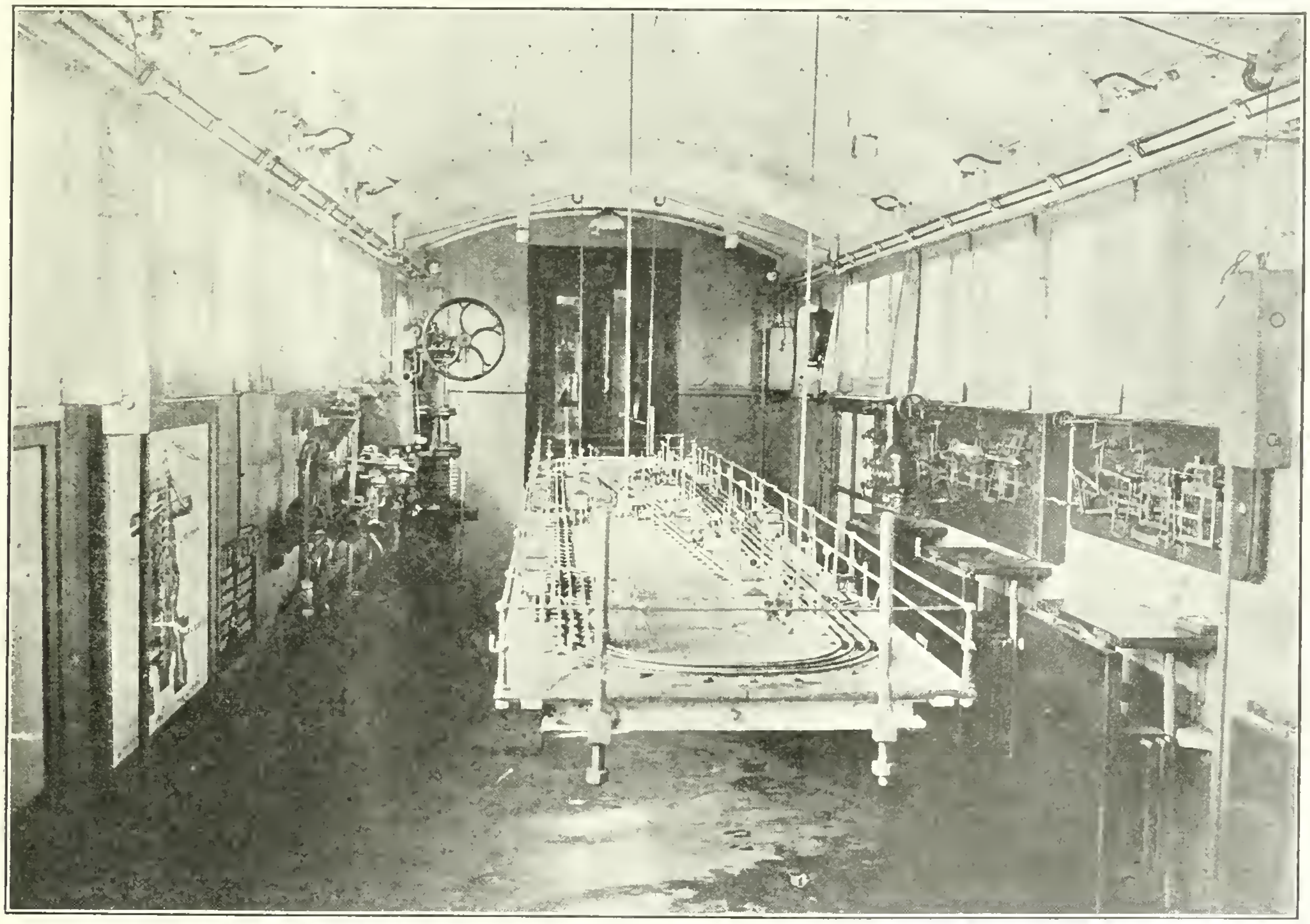
Vol. XXXVI 114 Liberty Street, New York, May, 1923 No. 5

Instruction Car on the Orleans Railway

The First of Its Kind to Be Used in France

An instruction car has been built for the Orleans Railway of France that has a wider range of usefulness than the average car of the same character in this country, where it is for the most part devoted to the air brake or, at the most, to include a few points of locomotive operation such as the valve gear. The French car has the facilities for general instruction in the air brake, valve motion, signals and other allied subjects.

When the equipment of the car was first contemplated it was the intention to utilize one of the coaches belonging to the American sanitary service, which had a length of 52½ ft. But, because of the high price asked by the railway administration for such a car when the stock was put up for sale, that idea was abandoned, and one of the American box cars carried on diamond trucks with a four-



Interior of Instruction Car on the Orleans Railway Showing Model, With Tracks, Switches, Signals, etc., Which Can Be Raised to the Car Ceiling

wheeled French freight car was fitted up instead, the latter to serve as a storage car and to provide sleeping accommodation for the instructor. The dimensions of the box car that was thus converted into an instruction car are as follows:

Surface of floor, 36 ft. by 7 ft. 10 in., making a floor area of a little more than 283 sq. ft.

The height from the floor to the lower part of the curve of the roof is 6 ft. 6¾ in. and the rise of the roof is 13¾ in.

The bracing of the side walls has been completed with iron shapes so as to form so rigid a structure as to prevent any possible deformation of the framing. The door spaces, at the center of the side walls, were closed by a panel identical with the remainder of the construction, so as to preserve the general appearance of the original box car.

Doors have been cut in the same side walls near the ends, in addition to which there is a vestibuled communication between the two cars, and there is but one sliding door instead of two.

The vestibuled communication at one end of the main car connects it to the annex, to which further reference will be made later. Two sliding doors of the same type as those used on the French cars, where it is possible to pass from one to another, serve to close the openings to the vestibule.

The sheathing of the inner walls is of matched pine.

The window openings in each of the side walls have frames of quartered oak, measuring 21⅝ in. by 15¾ in. They are glazed with an opening of 21⅝ in. by 10 in. These fifteen window openings are placed in five groups, each of which is set in a moveable frame opening towards the interior and fastened by a latch.

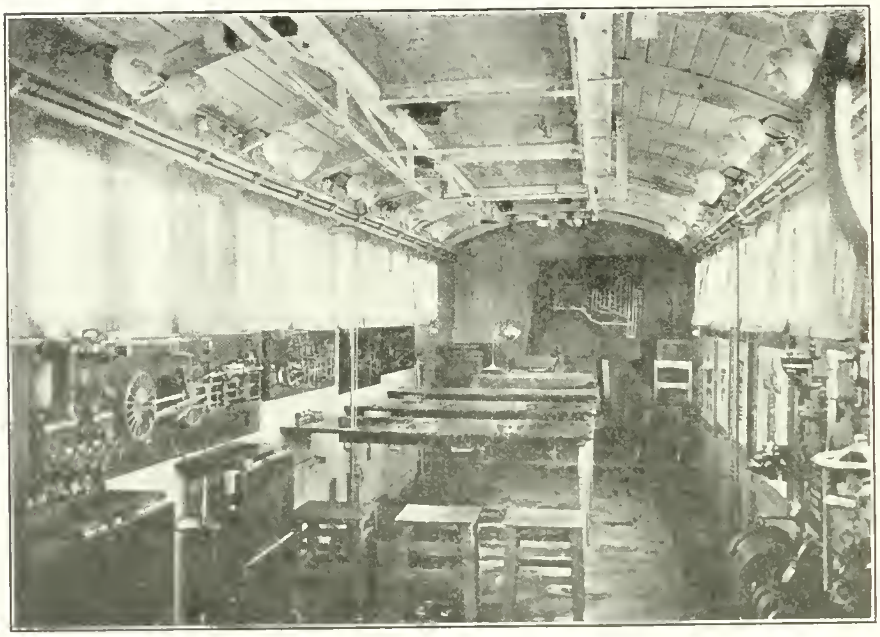
The total window area is about 45 sq. ft., or about one-quarter of the floor space.

The electric lighting of the car is effected by two distinct lines with separate apparatus; on one line there is a voltage of 110 and on the other one of 24. The first is fed by the different local currents of the system where the car happens to be stationed, and the second by a Stone's dynamo driven from one of the axles of the annex car and charging two accumulator batteries wired in parallel and having a total capacity of 240 ampere hours. This arrangement of two lines permits of an economical use of the accumulator currents, which would not be sufficient for long periods of standing. The circuit for each voltage, in the instruction car, is provided with twelve lamps of 25 candlepower each, each having its own switch.

The cars are heated by steam. The coupling hose and the piping are of the large section in common use. So that the instruction car and its annex can be put into mixed trains, where they are heated like the ordinary passenger cars, except that the chaufferettes have been replaced by radiators like those used in postal cars.

Two radiators with regulating cocks are placed at the ends of the side wall on the right hand side when facing the vestibule, each being composed of five elements. While standing steam is taken from the piping of a stationary plant or from some available locomotive.

The annex car, which is always coupled to the instruction car, is connected with it by a vestibule. It serves as a storage place for the parts of machines and models that are used in the various demonstrations as well as affording a sleeping room for the instructor. This annex car is one of the ordinary type, but which had already been somewhat modified in its upper framing from the common freight car, in the way of window and door openings, which had been added during the war so as to adapt it to the transportation of passengers. In this there is a transverse partition, with a sliding door separating the storage space for the demonstration models from the sleeping room.



Interior of Instruction Car—Model Railway Raised to Ceiling Permits the Use of Tables as Shown

A substantial framework, with shelves for holding all of the apparatus that is not permanently fixed in the instruction car is set along the center. In the corner, on the right hand side, there is a bench and vise for setting up and dismounting the various parts of the apparatus. The same systems of heating and lighting are used for the annex as for the instruction car.

In the instruction car there are five tables with folding leaves. They are arranged along the side wall on the left hand side looking towards the platform, and they have a length of 5 ft. each and afford accommodations for fifteen pupils to take notes during their lessons. These tables, with their leaves raised, fold up along the wall so as to make it possible in a few minutes to change the interior from a recitation to a lecture room with accommodations for forty auditors. In addition to the fifteen stools at the tables, there are a number of light, knock-down benches that are kept in the annex car for use by a lecture audience. The platform, having a superficial area of about 52 sq. ft., is located at the end of the car opposite the vestibule and is raised about 4 in. above the floor of the car. It contains a desk and seat for the instructor, a blackboard on an easel and two cases for papers. The demonstration apparatus that is set up in the instruction car is arranged along the two sides and in the center.

Arranged along the right side, looking towards the platform, there is first a Westinghouse compound air compressor. This pump is cut away in a number of places, giving a veiw of the arrangement of the operating parts as well as the course of the passages followed by the steam and compressed air. The movement of the valves, as well as that of the air and steam pistons, is reproduced by a simple mechanism consisting of a hand wheel and crank, cams and tappets.

In order to facilitate observation of the differential system which operates the horizontal distributing valve of the steam pump, at the upper part of the same, there is a large square section cut away, so that the admission and exhaust parts are exposed to view. A mirror placed against the wall back of the pump reflects the image of this square section, so that several men can readily follow the movements of the differential system and the distributing valve at the same time as it occurs at the end of each stroke of the steam piston.

For the sake of simplicity no attempt has been made to reproduce mechanically the lifting of the eight air valves, but this lifting is indicated by an electric bulb which lights at the proper time. When the valve should return to its seat the electric bulb which it carries is extinguished.

The operation of the Westinghouse compound pump presents such a complicated matter to employes that the examination of drawings and the study of explanatory notes is not always sufficient to give them a full understanding. With this demonstration model as thus machined it is quite sufficient for the instructor to manipulate the pump by means of the hand wheel. The audience sees each part move in the same way as in actual operation, and they can follow with the finger through the different passages of the steam and air pump that are cut away the paths followed by the steam and compressed air. Any verbal explanations of the demonstration that may be necessary in order that all may understand this ingenious apparatus may then be added.

Next to the compound air pump, which is independent of the other apparatus, there is a complete Westinghouse brake apparatus from the main reservoir, which is fed from the brake pipe of the instruction car to the brake cylinder, whose piston movement is opposed by powerful springs, thus permitting each pupil to study the operation of the different parts and their relationship to the other organs of the brake. A faulty manipulation of the equalizing discharge valve can thus be corrected, as well as the movement of the equalizing valve itself be made visible by the replacing of the bronze cap over the valve by one of thick glass. All of the brake apparatus, the equalizing discharge valve, quick action triple valve, regulating valve, etc., are duplicated with a part cut away and accompanied by a wash drawing on a large scale so as to facilitate a careful study of the details. Furthermore, parts that have failed in service are replaced in the presence of the pupils in the course of the lesson.

The alarm signals that are accessible to the passengers in the cars are located next to the brake apparatus. There is the electric intercommunication with its push button, indicator, galvanic battery and its bell, as well as the pneumatic method of intercommunication with its interlocking signal and its alarm whistle in an operating condition and readily dismounted for the purposes of a lesson.

Charts mounted on cloth illustrating the methods of heating and lighting passenger and other cars are located next to the electric and pneumatic intercommunication signals. For the purposes of a lesson they are fastened on moveable panels which are kept in the annex car.

On the left hand wall of the car, starting at the vestibuled end and running to the platform, there are arranged, first, a Haussaelter chronotachemeter, used for registering the speed of locomotives and so set up as to facilitate the study of the several parts of which it is composed.

Second, there are drawings without end, mounted on cloth, for the study of the hydrostatic lubricator for locomotive cylinders, starting with the filling, before being put into service, and continuing down to the complete exhaustion of the oil.

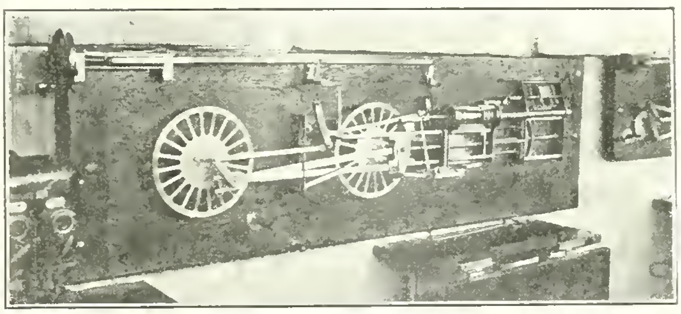
Third, a five-feed hydrostatic lubricator and stop cock, cut away in section.

Fourth, above the moveable tables there are several working models, which reproduce the movement of valves and pistons of the valve gears used on the locomotives of the company, such as the Walschaert, Gooch, Joy, etc. there are two special models of compound locomotive valve gears.

To assist in the study of the signaling system an oak table 7/8 in. thick by 18 ft. long and 2 ft. 7¾ in. wide, and rigidly trussed, carries a model consisting of three double track blocks, three single track blocks and a branch line forming a junction at each end with the preceding lines. The track as thus laid out has a gauge of 1 in. and a length of 197 ft. All of the signals are located to scale and in their regular positions.

The signal masts are operated by cord and lever control; the semaphores for the block system have an electric control and protection with an arrangement for announcing the approach of trains, which is the same as for regular service apparatus. On the single track line an electric arrangement with a light and bell makes it possible to announce the approach of a train and reproduce the acoustic signals of the electric clocks.

This signaling model has been designed for the purpose of obtaining an apparatus occupying a limited space by which men in training for the control of train operation may be given an opportunity of solving all of the problems pertaining to safety, especially in the matter of the protection of trains in case a signal fails to operate or some service accident, as well as in the training in the application of general orders and various instructions.



Walschaerts Valve Gear Model in Instruction Car of Orleans Railway

It is possible to have the man undergoing the examination go through all of the regulation movements for the several cases of momentary operation of the single track portion as well as those of the double track, and to meet the emergencies of the tender running short of water, breakage of a car coupling, and a study of the best methods of handling a wrecking train. The important problems of operation on a single track line, such as changes in meeting and passing points, the doubling past passenger trains, etc., can be solved in such a way that, when it comes to actual practice, there will be no question in making a rigorous application of the regulations.

This model of a signal installation is moveable, is balanced by four counterweights and is suspended by means of cables and pulleys from the roof, so that it can be lifted out of the way and be made to occupy a position up under the arch of the ceiling. It thus leaves the room quite clear of obstruction when it is so raised.

The instruction given in the car in the future will be made to include the use of lantern projections. The darkening of the windows, necessary to the visibility of these projections, will be accomplished by the use of the moveable panels already referred to, which serve at the same time as supports to which the drawings and designs, which serve to illustrate the different mechanisms, are fastened.

These drawings, which are kept in the annex car, are set before the pupils at each lesson. The different parts of the locomotives and rolling stock, as well as illustrations of modern machine tools, are in turn set up on the moveable panels. They serve to supplement the explanations of the instructor and assist the pupils in fixing their knowledge of the subject matter of the lecture.

The storage space of the annex car contains a certain number of different parts of locomotives, cars and machine tools, with sides cut away or transformed in other ways into demonstration models. Any of these models which appertain to the subject of the lecture are always available for the use of the instructor.

In addition to this there are arranged on the side walls of the annex car some moveable pictures of specimens and test pieces of different materials used in the construction and repairing of locomotives and cars, which are used in the course of general technology and metallurgy.

In addition to this there is a collection of pictures of the types of tools used in the various shops made with the regular sections, which are always available to pupils of the course who can consult the proper file.

The annex car also contains a library containing a collection of general orders and instructions for the several services of the road, among them being the work of the engine and train crews and shop workmen, the repairing of the equipment, the measures adopted for safety and hygiene, washing appliances, wrecking cars and cranes, inspections, the handling and storage of combustibles, etc. These are all available for the instructor to use as occasion demands. A number of technical works that serve to complete certain portions of the courses by correspondence form a bibliography attached to this collection of general orders and instruction.

Finally, the annex car also contains the apparatus for measurement and verification of matters cited in the theoretical portions of the courses in mechanics and electricity or in physics, which are available at any moment for the lessons or examinations of employes in service or those apprentices who are taking an advanced course. These machines include an Atwood machine, a Toricelli tube, and apparatus for electrical measurements.

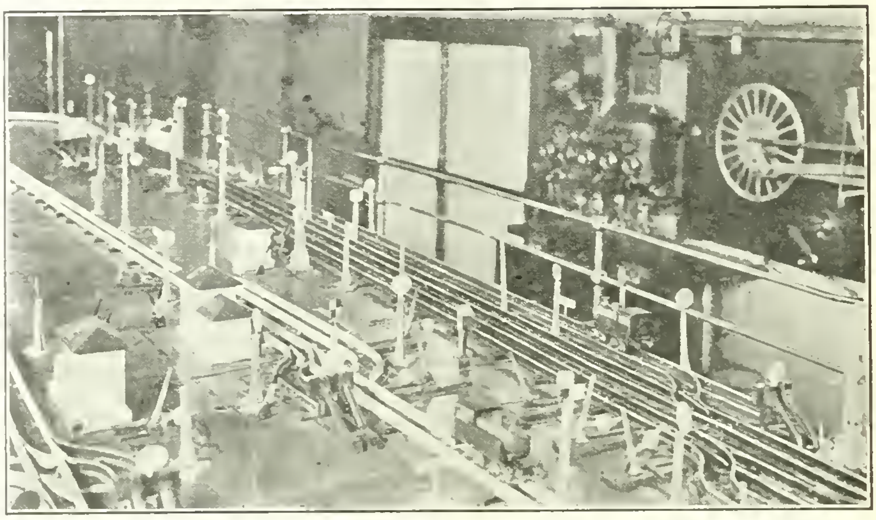
Commissioner Eastman Describes Powers of I. C. C.

Honorable Joseph B. Eastman, of the Interstate Commerce Commission, who has been appointed for another term of six years, said in a recent address in Boston:

"The Interstate Commerce Commission probably exercises the most comprehensive powers of regulation over a privately owned industry ever conferred upon a public body. It has power to fix both maximum and minimum rates, power to prescribe divisions of joint rates, power to control and regulate freight service, the distribution of cars, and the use of terminal properties. Without its approval, no bond or share of stock may be issued; no consolidation, lease or any other means whereby one company gains control of another may be effectuated; no new lines may be constructed, and no old line may be abandoned. It prescribes the manner in which accounts shall be kept, ascertains property values, has control of a fund from which carriers receive loans, is charged with the duty of devising a plan for the consolidation of the railroad properties into a few great systems, and by implication has even some measure of responsibility for the economy and efficiency of their management."

Virginian Railway to Electrify

In order to increase its traffic capacity and to secure important operating economies, the Virginian Railway has decided to electrify 213 miles of its track lying between Roanoke, Virginia, and Mullens, West Virginia. This undertaking will involve the expenditure of $15,000,000. The order for the electric locomotives, power house, transformer stations, and other apparatus has been awarded to the Westinghouse Electric & Manufacturing Company, and forms the largest railroad electrification contract ever placed. The division to be electrified crosses the Allegheny Mountains. The alternating-current, single-phase system will be used.



Section of Working Railway Model Showing Tracks, Switches, Signals, etc.

A feature of the electric locomotives will be the use of regenerative braking on the down grades. This method of braking will not only reduce the wear on the brake shoes and wheels and improve operation, but will also save 15,000,000 kilowatt-hours of electric energy per year.

Power for operation will be supplied by a 90,000-horsepower generating plant to be erected on the New River. This will supply 88,000-volt current to the main transmission line. For use on the trolley wire from which the locomotives will draw their power, this high-voltage current is to be stepped down to 11,000 volts by transformer stations placed at regular intervals along the line. On the locomotives, this is reduced to a low value for the operation of the motors.

The electrical apparatus will be built at the East Pittsburgh Works of the Westinghouse Electric & Manufacturing Company, where the large order for the electrification of the Chilean railroad is nearing completion and work on contracts for the Pennsylvania, Long Island, Norfolk & Western, and New Haven railroads is in progress.

Investigation of Power Brake

Upon consideration of the record of the Commission's investigation of power brakes and appliances for operating brake systems, the Interstate Commerce Commission has ordered a reopening of the hearing for the purpose of a test by the Commission of the Automatic Straight Air Brake upon the Norfolk & Western Railroad. The date for the test has not yet been fixed.

Locomotive Lubrication

A Review of Early Practice and Comments on the Hydrostatic vs. Force Feed or Power Lubricators

By W. E. SYMONS

From the construction of the first steam locomotive in 1828 to the present day, one of the most important and at times perplexing problems has been that of lubricating the valves, cylinders and driving journals, other parts requiring lubrication having been less troublesome to designers or operating officers.

A review of some incidents in connection with this question is of more than passing interest.

At the annual meeting of the American Railway Master Mechanics' Association at Louisville, Ky., 1871 (52 years ago), a committee reported that from the best information obtainable from various sources, local conditions more than any individual merit of one oil over another seemed to govern. The consensus of opinion however, was expressed in the following language of committee's report on the subject:

"The general preference seems to be largely in favor of the use of lard oil mixed with a proportion of earth oil of a gravity of 28 degrees or 29 degrees to keep it thin in winter. For fast passenger trains pure lard oil seems to afford the best results, while on slow freight trains heavy earth oils are equally successful, unless a journal should become over-heated, when it is almost impossible to cool it with any of the different varieties of earth oils.

"In lubricating cylinders, pure refined tallow, clear of acids, meets with most favor; although some prefer tallow oil in winter. Lard oil is also used to some extent for this purpose, securing complete immunity from dirt in pistons or in cylinder heads, and from the wasting of valve yokes so often seen when tallow is exclusively used. A system of steam lubrication is also mentioned as being successful. A sufficient quantity of steam to lubricate the valves and cylinders, but not enough to accelerate the speed on descending grades. A little tallow is used with it, about one pound per one hundred miles. By use of this process brass rings are reported as wearing ¼ inch in 44,652 miles' running.

"The use of plumbago, mixed with tallow, is highly recommended for cylinders, as giving them a smooth glazed surface, and is perhaps the best lubricant known for this purpose, as by its use the disastrous effects of acids in tallow are entirely avoided. There has heretofore been a difficulty experienced in procuring this material entirely free from foreign substances, especially quartz. But this objection to its use is obviated in the manufacture of chemically pure plumbago.

"Plumbago grease for journals has not been extensively enough used to warrant as yet its general adoption, although parties using it heartily commend it as a journal lubricator of great value and a sure prevention of hot boxes. The manufacturers claim that it is infusible and practically indestructible, as neither a heat of 4,000 degrees nor a temperature of 50 degrees below zero, nor acid, nor greases, affect its condition. Experience proves that it forms on wearing surfaces a coating of extraordinary smoothness, and from its pasty condition is not liable to be thrown from the journal boxes, as are the oils ordinarily used for this purpose."

The next report by a committee of this body was submitted at their annual meeting in New York in 1875, which indicated that 15 master mechanics out of 20 used tallow exclusively for valves and cylinders, one line got 105 miles per *quart*, one 117 per *quart*, D. L. & W. 56 miles per *quart*, C. R. R. of N. J. 27 miles per *quart*, and P. W. & B. 22 miles per *quart*. The general verdict was in favor of pure tallow, and general preference favorable to cab tubes to supply oil to cylinders and valves.

For guides and journals petroleum mixed with lard, fish oil or tallow gave good results.

The subject was a slippery one, and the Railway Master Mechanics' Association equally so in committing themselves to any standard practice or lubricant, as only 26 members responded to inquiries sent to all lines for information on the subject.

In 1877 and 1878 tallow, tallow oil or lard fed through pipes from engine cab to valves and cylinders was still accepted practice.

In 1884 quite a lengthy report was submitted to the association, and tallow was still principally used with valve oil, a mixture of petroleum and animal fats was used by some, and the sight feed lubricator was first introduced.

In 1894 the question of lubricating oils was gone into at much length, many methods or devices and character of lubricants were mentioned. What was then considered a long run, 135 to 140 miles for passenger engines, called for special facilities for lubrication, particularly axle boxes, the Lake Shore and the Erie provided an extra fount of oil on running board with feed pipes to journals, and by this means the long runs were successfully made.

The use of Galena oils were at this time being quite generally used in this country, while in England a mixture of 33 per cent rape with 66 per cent mineral oils was pretty generally used, although some used 50 per cent of each.

At the Master Mechanics' Convention of 1900, much time was devoted to the question of lubrication, journal bearings, lubricators, etc., but there was no mention of grease for driving journals. The hydrostatic lubricator being the only device considered for delivering oil to valves and cylinders.

At the Master Mechanics' Convention in 1904 the use of grease for driving journals and crank pins was practically endorsed, and the "Elvin" grease cellar was the only device mentioned suitable for proper application of grease to driving journals.

High steam pressures, with correspondingly high temperature, was giving considerable trouble in lubrication of valves and cylinders, and the experts of hydrostatic lubricator companies, with those of the Galena Oil Company were actively engaged in trying to find a satisfactory solution of this problem.

Many new improvements were made both in character of cylinder oils and devices employed in its application with varying degrees of success, for while some roads reported complete cures, others using the same remedy claimed to find little or no relief.

Force Feed or Mechanical Lubricator

The successful use of force feed lubricators in stationary and marine practice throughout the country and on locomotives abroad prompted resort to the method in this country, and after considerable experimental work and much expense, there was in use on locomotives in the United States on January 1, 1919, something over 700, or about 1.12 per cent of the total engines equipped with the Schlacks system of force feed power driven pumps, and since that time the force feed pump for the lubrication of valves and cylinders has made considerable progress, and from all reports bids fair to meet with more general favor in future.

Advantages of Power Driven Lubricators

One of the advantages, if not the principal feature in favor of the use of force feed in place of the hydrostatic sight feed lubricator is its dependability to supply a predetermined quantity of oil based on the service and capacity of the engine, and the absolute impossibility to overfeed or waste any oil by the engine crew, hostlers, or any one else, and while there may be times when the accessability of the hydrostatic lubricator to the engine crew for this purpose may serve to good advantage, its abuse or the great waste of oil from this source not only more than offsets this apparent benefit, but more than fully justifies the use of a device or system by which such waste is an absolute impossibility, and for this reason it looks reasonable to assume it will come into more general use.

It may be of interest to mention that on one of the best managed western lines, with an average mileage on valve oil of about 35 to the pint, and life of cylinder packing rings of less than 20,000 miles, with hydrostatic sight feed lubricators, several heavy passenger engines were equipped with force feed lubricators only and the mileage was increased to above 80 per pint of oil, and cylinder packing rings were inspected that had made from 90,000 to 115,000 miles and found to be in perfect condition with so little wear as to be hardly noticeable. This is certainly a splendid endorsement of the force feed lubricator, and incidentally may be a criticism of the method of using the hydrostatic, from which such poor results were obtained.

From the foregoing one may form an idea of the great waste of lubricating oil and the consequent expense resulting therefrom when small saturated steam engines with a pressure of 150 to 180 pounds, and cylinders 15 to 18 inches in diameter, used or wasted one *quart* of oil in a distance of 117 to as low as 22 miles, when today, engines many times in size and capacity, make more miles per *pint* of oil than was then secured from one *quart*. To those who originated and introduced the feature of "Cost of Lubrication per Thousand Miles," credit is due for having saved the railways many hundreds of million dollars on this item alone, while the principle extended to and resulted in great economies in other directions.

Comparison of Hydrostatic vs. Mechanical Lubricator

Hydrostatic Lubricator

The arguments *in favor* of the hydrostatic lubricator are as follows:

1.—It is extremely simple, cannot get out of order, and has a low first and maintenance cost.

2.—It is always under the control of the enginemen who can check the oil feed, and can increase this in emergencies, as in the case of a "blowing" engine, or where the use of bad water must be offset by increase in cylinder oil feed.

3.—The oil is fed on the basis of time and not on the basis of piston travel, thus giving the maximum amount of oil when it is most necessary, i.e., under heavy load.

4.—As the oil is introduced into the cylinder by steam, or, as it is sometimes expressed, is carried by steam, good distribution of the oil is effected even when drifting. Furthermore, the steam in the lubricator keeps the oil fluid at all times and assists in its atomization.

5.—As it feeds on the time principle it always gives an ample supply of oil for the locomotive when starting.

6.—There being nothing to get out of order it is absolutely dependable and will function so long as there is steam in the boiler and the lubricator valves are open.

7.—It forms less carbon than the mechanical lubricator.

Against Hydrostatic Lubricator

The argument *against* the hydrostatic, as offered by the proponents of the mechanical lubricator, are as follows:

1.—The feed is based on time only, regardless of the rubbing speed of the piston, which is manifestly illogical.

2.—The rate of speed is controlled by the engineman which is a disadvantage, since few enginemen have a real conception of the science of lubrication and the general tendency is to overfeed, causing carbon formation.

3.—It must be shut off when standing to avoid oil wastage and carbonization. Where frequent short stops are made—as in local train service—the enginemen are not likely to shut off the oil feed and, therefore, the consumption of lubricant is greater than is necessary or desirable.

4.—When running under full load with full boiler pressure in the cylinders the oil feed is simply due to the small column of water in the lubricator. On the other hand, when drifting, the oil is fed under heavy pressure. This is bound to cause irregularity in feed and excess quantities of oil being supplied to the cylinders when drifting, tending to produce objectionable carbon. Probably one reason that the advocates of the hydrostatic lubricator claim that lubrication under heavy load is difficult, is due to this very fact, since at such times the pressure on either side of the lubricator is almost equalized, and there is very little force left to carry the oil through the long length of pipe extending from the engine cab to the steam line.

Mechanical Lubricator

The arguments used by the advocates of the mechanical lubricator are:

1.—The feed is based upon the actual rubbing speed of the moving parts.

2.—The rate of feed being set by the shop crew this cannot be varied according to the whim of the enginemen. Therefore the oil may be set at the minimum rate to give satisfactory lubrication, thus reducing the formation of carbon. Furthermore, there can be no waste of lubricant by the enginemen forgetting, or not troubling, to shut off the lubricant when the locomotive is standing.

3.—Oil is only fed when required. It starts as the locomotive starts and stops as the locomotive stops.

4.—It is absolutely fool-proof, is adjusted and filled by the Maintenance Division, taking the responsibility out of the hands of the enginemen and putting it in the hands of those who are responsible for the maintaining of the locomotive in proper running condition.

5.—Regardless of whether the engine is running or drifting, the oil is always fed under the same pressure, thereby assuring an absolutely regular and constant oil feed.

6.—Because of various reasons outlined above, it is capable of giving efficient lubrication with far less oil than the hydrostatic.

7.—It contains no explosive pressure.

8.—It gives less for the enginemen to attend to.

9.—If desired, it can be so driven from the valve action as to deliver an increased quantity of oil for heavy loads, i.e., long cut-off.

10.—It can be used to lubricate the axle boxes also if desired.

Against Mechanical Lubricator

The arguments *against* the mechanical lubricator are as follows:

1.—It is costly both to install and maintain.

2.—It gets out of order easily.

3.—It is out of control of the enginemen, who furthermore cannot be certain that the oil is feeding.

4.—It is affected by temperature changes.

5.—It does not take care of the Westinghouse Air pump.

6.—If the locomotive drive on the lubricator fails, lubrication is not obtainable.

7.—It is disliked by many enginemen.

8.—It will not lubricate a blowing engine, since the feed cannot be increased by the driver.

9.—It will not take care of heavy load conditions.

10.—Wear in the drive mechanism affects the rate of feed.

11.—When drifting the oil is not carried into the cylinder by a steam jet, as in the case of the hydrostatic lubricator, and for the same reason, there is no real atomization of the oil in such cases. This forms carbon faster.

12.—It feeds the oil on the wrong principle, since more is required at low speeds and heavy loads than at high speeds and light loads.

So much for the arguments for and against each type of device.

We will not discuss further the arguments advocating the two different lubricators, but we believe that a few comments might be desirable as to those *against each.* We will, therefore, take them up herewith by number.

Against the Hydrostatic

1.—This is open to discussion. It must be admitted, however, that the rubbing speed is an important factor in all lubrication analysis.

2.—On the majority of railroads the engineer has a fixed oil allowance he cannot exceed, and a competent man will vary his rate of feed to meet the requirements. The point is open to discussion, however, and it is worth noting that the advocates of the mechanical lubricator place just as much stress on its being desirable to take the control of the lubrication out of the enginemen's hands, as the supporters of the hydrostatic lubricator place on its being an advantage. And each side has excellent arguments and can cite experience to prove its contentions. Unquestionably a first class engineer can get excellent results with a hydrostatic lubricator. The problem is rather as to whether the mechanical lubricator does not give greater economy with the *average* engineer.

3.—Granted.

4.—We have been unable to obtain any logical disproof of this argument.

Against the Mechanical

1.—It is admitted that the installation is costly. Also the maintenance may be conceded to be more expensive than that of the hydrostatic lubricator, but it is not "costly" where a properly designed and applied mechanical lubricator is used. Furthermore, the saving in lubrication which is obtainable more than offsets the increase in maintenance cost.

2.—This does not seem to be substantiated. It may perhaps have been true of the spring-operated-valve type of mechanical lubricator, although it is not of the present valveless design.

3.—As indicated in No. 2 under the discussion of arguments against the hydrostatic lubricator, this point is open to debate. Both sides have excellent arguments to support their contentions. Judging from the class of enginemen in many foreign fields, and the general attitude of enginemen in this country on this question, we would be inclined to think that control of lubrication should primarily rest with mechanical officers. Furthermore, it must be admitted that the human element after all is more likely to fail than is the mechanical. However, it is possible to control and regulate the oil feed from the cab if desired, and this is done in several European countries, although we have as yet no details of the devices employed. Also, many lubricators, not cab controlled, have tell-tales visible from the engineer's seat.

4.—Advocates of the mechanical lubricator claim that in a properly designed device—and each one insists that he makes or uses it—temperature changes have no effect on the oil feed. This would seem a subject for impartial investigation.

5.—Granted—but this does not seem to be a really serious objection.

6.—Granted—but also of relatively little importance. The hydrostatic lubricator would fail if its steam lead broke.

7.—This is really not a valid argument against the ability of the lubricator itself. It must be admitted that many enginemen are antagonistic, and endeavor to discredit the operation of the mechanical lubricator.

8.—Granted. There is no question but what there are cases where trouble develops on a run, and repairs cannot be made until the end of the run is reached. In such a situation there can be no question of the desirability of being able to supply an excess of oil to the mechanically defective cylinder. The question here is rather as to whether this disadvantage is not more than offset by the various advantages of the mechanical lubricator.

9.—If we are to accept as correct the teachings of our own engineers, as set forth in our Educational Training Course, we cannot admit that a heavy load is a more difficult position to lubricate with a mechanical lubricator, although we can see where it might be with a hydrostatic, for the reasons set forth in argument 4 against the hydrostatic lubricator. It would appear to us that the delivery of the proper amount of oil for both light and heavy loads is largely a question of setting. If a mechanical lubricator is adjusted to give the proper amount of lubricant per stroke, when the engine is working under a heavy load, it will unquestionably continue to do so under a light load.

10.—This does not seem to be based on any really sound foundation.

11.—We cannot feel that this point with regard to drifting is really supported. Modern practice very generally involves the use of drifting valves, and the steam thus admitted is in excess of the small amount which is introduced by a hydrostatic lubricator. Thus there *is* a medium to carry the oil admitted during drifting by a mechanical lubricator. Furthermore, it must be granted that owing to unbalanced pressure, the hydrostatic lubricator is likely to feed excess oil at such times. With a properly set mechanical lubricator less carbon will form. Where carbon trouble has been experienced with the latter device, it has usually been due to the instrument having been set on the basis of the rate necessary for the hydrostatic lubricator, which would be too much.

12.—This is open to discussion. We are inclined to disagree.

The above sums up, as concisely and impartially as possible, the data which we have been able to collect from various sources. We are inclined to believe that the mechanical locomotive lubricator is growing in interest with the advent of the improved types, and with the introduction of larger cylinders and higher steam pressures and temperatures.

Fuel Association Convention Papers

A well-founded program of interest to railroad officers and coal operators has been arranged for the annual meeting of the International Railway Fuel Association to be held at the Hotel Winton, Cleveland, Ohio, May 21-24. The following list gives the addresses, papers and reports which have already been definitely arranged. The opening address will be made by Julius Kruttschnitt, chairman of the executive committee of the Southern Pacific. Mr. Kruttschnitt has chosen as his subject Railway Fuel —

A Reducible 13 Per Cent of Operating Expenses. H. M. Griggs, manager of the Ore & Coal Exchange, Cleveland, will address the convention on Lake Coal Handling, and C. E. Maurer, president of the Glens Run Coal Company, will deliver an address on a subject to be selected later.

The subjects of the individual papers and the authors are as follows: Value of Individual Performance Record, L. G. Plant, editor, *Railway Review;* Extension of Locomotive Runs, C. B. Peck, western mechanical editor, *Railway Age;* Economic Aspects of the Fuel Oil Situation, C. E. Beecher, acting chief petroleum technologist, U. S. Bureau of Mines; Incentives for Promoting Fuel Economy, O. S. Beyer, Jr., consulting engineer; Classification of Coals, Geo. H. Cushing, publisher, *Cushing's Survey;* The Fuel Saving Aspect of Boiler Water Treatment, C. R. Knowles, superintendent water service, Illinois Central; The Effect of Tonnage Rating and Speed on Fuel Consumption, J. E. Davenport, superintendent fuel and locomotive performance, New York Central; The Other Ten Per Cent, R. S. Twogood, assistant engineer, Southern Pacific; The Superheater — Its Use and Abuse from a Fuel Economy Standpoint, Bard Browne, service engineer, the Superheater Company; Refractories for Oil-Burning Locomotives, J. C. Martin, Jr., vice-president, Aetna Combustion Company; Economy in the Heating of Stations and Buildings, R. W. Noland, professor of heating and ventilating, Purdue University.

The following standing committees will also present reports; Firing Practice (Chairman S. H. Bray, Southern Pacific); Fuel Accounting, Distribution and Statistics (Chairman B. A. McDowell, Baltimore & Ohio); Fuel Stations (Chairman W. E. Dunham, Chicago & North Western); Front Ends, Grates and Ash Pans (Chairman Prof. E. C. Schmidt, University of Illinois); Boiler Feed Water Heaters (Chairman E. E. Chapman, Atchison, Topeka & Santa Fe). The Committee on Storage Coal of which the late Prof. H. H. Stoek was chairman, will also present a report.

The Air Brake Association

Probably no educational agency is doing greater service for the railroads than the Air Brake Association; and this, too, at its own initiative and at its own expense. Its 1,200 enrolled members, through ambitious desire to become more proficient in air brake practice and to study the mechanisms of this marvelous and greatest of all train safety devices, put into practice many testing, inspection and maintenance features originally thought out as theories, more or less nebulous, and the aggregate result of such development work is discussed in an educational way at the association's annual May convention.

Not only has the Air Brake Association developed a large school of air brake students, but it has gone further and has become a very great help to the large army of general railroad employees as publisher and distributor of air brake instruction books, of popular character and price. Thousands of the association books are sold yearly and contribute to the association a goodly proportion of its revenue for carrying on its work.

During the recent strike the association lost heavily in defaulted membership dues and through diminished book sales. However, these sources of income have greatly improved with resumption of normal operations, and are at present very satisfactory.

The Air Brake Association's convention was held in Denver, May 1 to 4, and a report of the meeting will appear later.

Centennial of the Delaware & Hudson Co.

The one hundredth anniversary of the incorporation of the Delaware & Hudson Company by act of the New York State legislature was celebrated on April 23 and 24. The program included a dinner at the Hotel Astor, New York, on April 23, and a trip by the president of the company with a party of about 60 on a special train from New York to Wilkes Barre, Scranton, Carbondale and Honesdale, including a luncheon at Scranton on April 24.

About 600 guests, men prominent in every walk of life, attended the dinner, which was one of the most notable of its kind ever held in New York. The first locomotive to run on a railroad in the United States was the Stourbridge Lion, a Delaware & Hudson locomotive, and before the speakers' table there was a working model of the engine, and at either end of the table were models, done in sugar, of the America, a D. & H. locomotive, and the first to be imported into this country, and a Mallet.

Eugenius H. Outerbridge, chairman of the Port of New York Authority, presided and L. F. Doree, president of the company, was toastmaster. The speakers were James S. Alexander, president of the National Bank of Commerce, New York, and H. W. Dickinson, honorary secretary of the Newcomen Society, and assistant to the director of the Science Museum, South Kensington, London, England.

Mr. Alexander spoke on "Banking and Transportation," and dealt with the intimate relationship between transportation and credit.

Mr. Dickinson spoke on the "Use of Steam Power," and traced the development of the steam engine from its beginning up to the perfecting of the steam locomotive.

In the beginning of his address, Mr. Loree gave a history of the founding of the Delaware and Hudson Company and then briefly sketched a history of railway regulation. Continuing on this subject he said:

"The plan of regulation that developed the greatest popularity involved the creation of commissions, the essential characteristic of which is that although their members are usually appointed in the same manner as the subordinate members of the executive branch of their governments, they really exercise the power of a legislature. The distinctions among the three classes of governmental power are that (1) the legislature establishes rules of conduct, (2) the judiciary interprets and applies these rules, (3) the executive enforces them. But these commissions make rules of conduct for the future which are distinguishable from those made by a legislature only by the fact that the former are special rules applicable only to the conduct of the parties to a proceeding before the commission, while true legislature must always fix rules of general application.

"Thus those subject to such commission rule are no longer controlled by general rules of conduct applicable to all similarly situated, but, in case after case, these commissions set up special rules of conduct controlling only the parties to the particular proceeding and no more, therefore, than the rule of the case. Unlike judicial determinations, these commission proceedings are not the interpretation and application to the special facts of a controversy of a pre-existing rule of conduct.

This system of control, so repugnant to the genius of American political ideals and institutions, gradually developing for the past 50 years, has eaten like a cancer into the stability of the railway industry, and at this moment seriously threatens its economic efficiency and the general welfare of the American people. It no longer now affects every undertaking in the so-called "public utility" field; but those in which the capital used is held, in law, to be "charged with a public interest."

The Kunze-Knorr Air Brake

A Description of a Recent German Development An Automatic Braking System

In Railway and Locomotive Engineering reference has been made to the use of a new type of air brake on the State Railways of Sweden. This is known as the Kunze-Knorr brake and is based upon the principle of a single cylinder automatic compressed air brake.

With the Kunze-Knorr brake the graduation up and down is obtained by placing a pressure transformer between the auxiliary reservoir and the valve chamber of the triple valve, by means of which the pressure in these two chambers rises and falls together in such a way that the pressure in the valve chamber of the triple valve is always higher by a certain ratio than it is in the auxiliary reservoir.

For this pressure the auxiliary reservoir is divided into two parts *A* and *B* by a movable piston as shown in Figs. 1 to 4; from one of which *B* the compressed air is drawn off to the brake cylinder, while the other *A* is connected with the valve chamber of the triple valve. The effective surface of the piston upon the side *A* is, therefore, the smaller of the two, when the piston is connected to the smaller counteracting piston, so that the forces acting upon the piston are balanced only when the pressure in *A* and with it that in the valve chamber of the triple valve is greater than it is in *B* in an inverse ratio to the effective surfaces of the piston.

If a brake application is made because of the reduction of the pressure in the brakepipe by a certain amount, and the triple valve be, thereby, moved into application position, then the air pressure will be reduced in the chamber *B*. The separate chambers thus follow the piston, and the pressure in *A* and the valve chamber of the triple valve also falls by expansion until it has fallen below the brakepipe pressure. Then, the triple valve piston will be pushed in the same way into its final position as occurs in the ordinary single-cylinder brake.

If, on the other hand, it is desired that the brake be partially released, and for this purpose, the pressure in the brakepipe, and with it that in the triple valve be raised so that the piston of the triple valve is moved into the release position, then air pressure will flow into the chamber *B*. The rise of pressure upon this side of the piston separated spaces *A* and *B* now varies because of the displacement of the piston in a ratio to the effective piston surfaces corresponding to the rise in the chamber *A* and the valve chamber of the triple valve. This rises above the brakepipe pressure and pushes the triple piston back into lap position. The process can be frequently repeated at will, since the piston of the triple valve will yield to a slight increase of pressure in the brakepipe and also, in order to bring the piston back into lap position, a very slight rise in the pressure in the valve chamber of the triple valve will suffice.

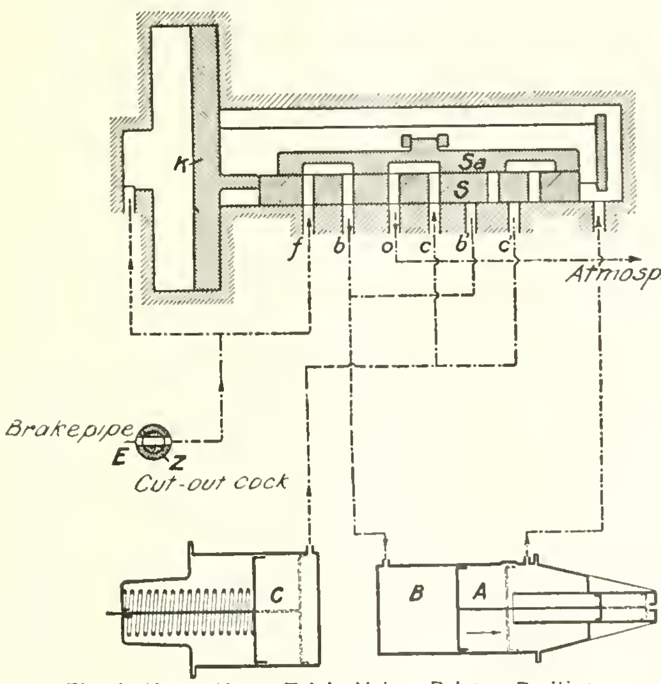


Fig. 1—Kunze-Knorr Triple Valve—Release Position

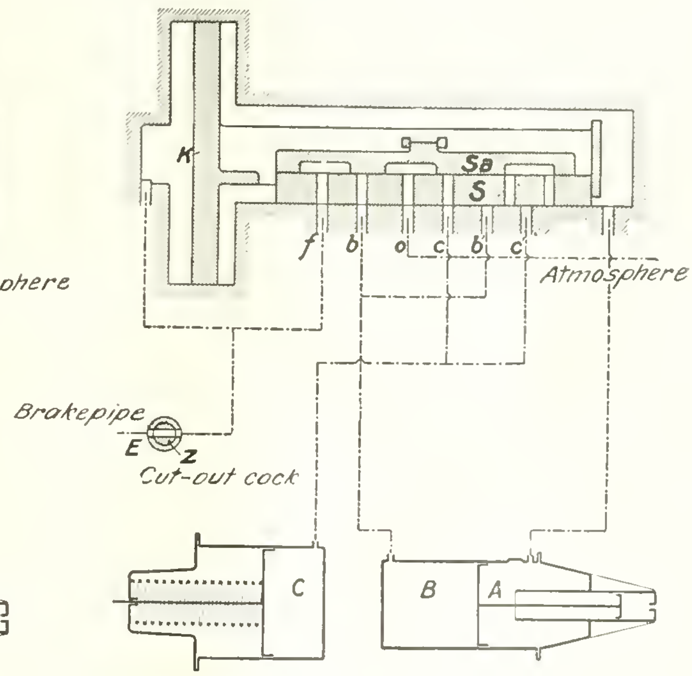


Fig. 2—Kunze-Knorr Triple Valve—Release Lap Position

These movements are shown in Figs. 1 to 4. Fig. 1 shows a position where the release has not yet closed. The brakepipe air flows therough *f* over the top of the main valve *S*, through the port in the valve *Sa*, through the passage *b* into the auxiliary reservoir *B*, while the brake cylinder air flows, at the same time, from *C* over both valves through *o* into the atmosphere, while the piston separating *A* and *B* moves to the right under the influence of the increasing pressure in *B*. If a definite decrease in brake pressure is to be fixed by an interruption of a further flow of air into the brakepipe, the position of the parts of the triple valve (that is the piston *K* and the slide valve *S* and *Sa*) will remain unchanged, until the pressure in *A* overcomes the resistance of the piston *K* to movement. Then, the piston *K* together with the riding valve *Sa* moves towards the release and assumes the release lap position as shown in Fig. 2, in which the riding valve closes the connection between *f* and *b* (from brakepipe to auxiliary reservoir) as well as that between *c* and *o* (from the brake cylinder to the atmosphere). In Fig. 3, which shows the position of the parts of the triple valve at a brake application, the parts *K*, *S* and *Sa* have made their full stroke to the left in consequence of a fall in the brakepipe pressure; *B* is connected with *C* through the branch passages *b'* and *c'* and the two slide valves. The auxiliary reservoir *B* is discharging into the brake cylinder *C*, and the piston separating *A* and *B* moves back to the left because of the falling pressure in *B*. By an interruption of the fall of pressure in the brakepipe, the parts of the triple valve *K*, *S* and *Sa* will either, first of all, remain at rest until, because of a further flow of *B* (auxiliary reservoir) air into *C*, the pressure in *B* and, with it, the pressure in *A* and the valve chamber of the triple valve has fallen so low, that the excess pressure upon the brakepipe side of the triple valve piston *K* moves it and the

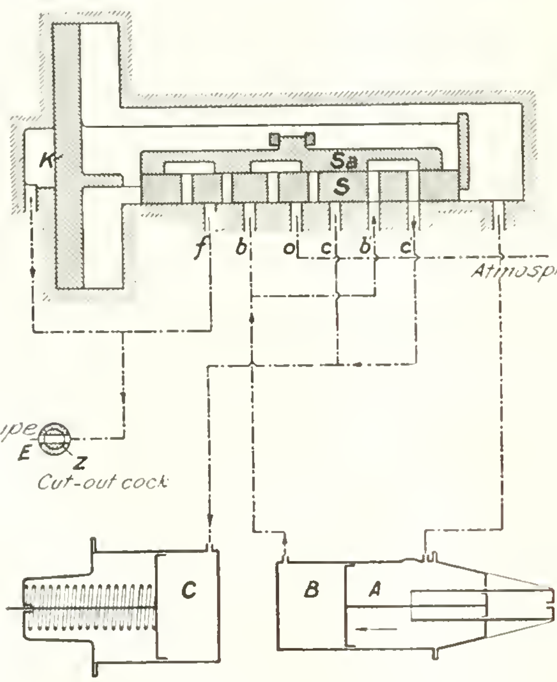


Fig. 3—Kunze-Knorr Triple Valve—Braking Position

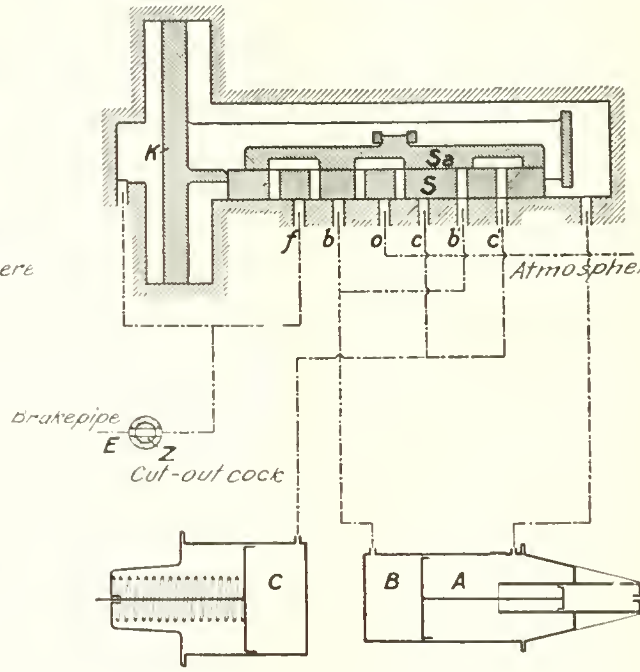


Fig. 4—Kunze-Knorr Triple Valve—Braking Lap Position

riding valve *Sa* to the right towards the exhaust position as shown in Fig. 4, in which *Sa* cuts off *b'* and *c'* from each other, which also prevents a further rise of brake cylinder pressure in *C*.

In this way a perfect graduation is obtained, hence the compressed air in the distributing chamber *A* will not be wasted, but its pressure will rise and fall only to an extent that corresponds to the movement of the separating piston, so that with the movement of the piston back into its original position, the original pressure will also be reached. At this instant also, the auxiliary reservoir will be fully charged, at the end of the release discharge.

The essential elements, of which the Kunze-Knorr brake avails itself in orer to secure the course of brake pressure lines described and here shown in Fig 5, are the transferring chamber (Ubertraugungs Kammer), the pressure reducing valve and a throttling hole, which is intercalated in the proper place in the passage leading from *B* to *C*.

Figs. 6 and 7 show a schematic arrangement of the Kunze-Knorr freight train brake in release and application positions in connection with the transferring chamber *U* and the pressure reducing valve *M*. In the valve face of the triple valve the ports *f* and *o* remain and *b* is connected with the by-passage *b'*, in addition there are the two ports *u* and *u1* arranged parallel to each other and leading to the chamber *U*. Further the branch passage *c'* is absorbed in the passages *c* and *c2* arranged parallel to it, the first of which leads to pressure reducing valve *M*, while *c2* contains the throttle hole (not shown in the illustration). In the diagram of the release position (Fig. 6) as in Fig. 1, *f* is shown as connected with *b*, *c* and *o* as well also *u1* with *o*.

In the lap position (not shown) these connections through *Sa* are interrupted and, with them the connection of the chamber, and *b'* is connected with *c* and application position (Fig. 7) *S* and *Sa* make a connection between *f* and *u* that is from the brakepipe to the transferring chamber, and *b'* is connected with *c1* and *c2*. Brakepipe air will flow into *U*; in addition to which the air in *B* will flow through the large cross section of the valve *M* and, at the same time, through the narrow contracted orifice in *c2*, into *C*. The pressure reducing valve immediately closes, so that the small preliminary brake pressure is soon reached; because the further flow of air from *B* into *C* can only take place through the passage *c2* in which the contracted orifice is located. In the application lap position (not shown) the connection

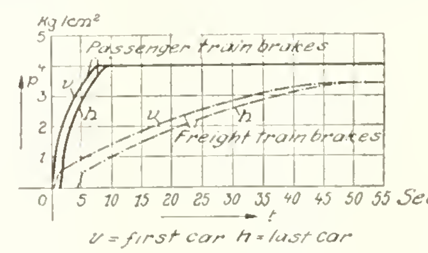


Fig. 5—Brake Pressure Diagram Lines for Passenger and Freight Trains

between *f* and *u* and that of *b'* with *c1* and *c2* is broken, so that the brake graduation in *C* is maintained.

The Kunze-Knorr brake is also a single cylinder brake, in so far as it has been herein explained, in that operation depends upon the pressure of air existing in a single cylinder, that is to say the cylinder *C*. The maximum brake pressure is obtained, as soon as the pressure in the auxiliary reservoir *B* flowing into the brake cylinder *C* becomes equalized therewith. The differential piston in the *AB* cylinder (auxiliary reservoir) serves solely for the purpose of regulation.

The presence of this piston now offers the simplest *means* at hand, to essentially increase the highest braking force and thereby also secure a braking in proportion to the weight of the loaded car. In order to accomplish this it is only necessary to connect the piston with the brake rigging and to discharge the air entirely out of *B*, so that the pressure in the chamber *A*, as exerted upon the piston will be added to the braking force of the pressure on the piston in the cylinder *C*.

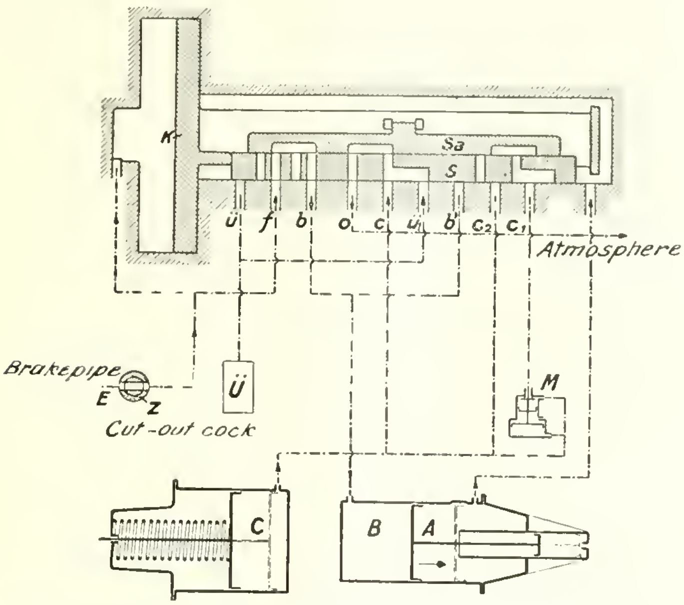


Fig. 6—Diagramatic Arrangement of the Kunze-Knorr Freight Brake, Reducing Valve and Transposing Chamber—Release Position

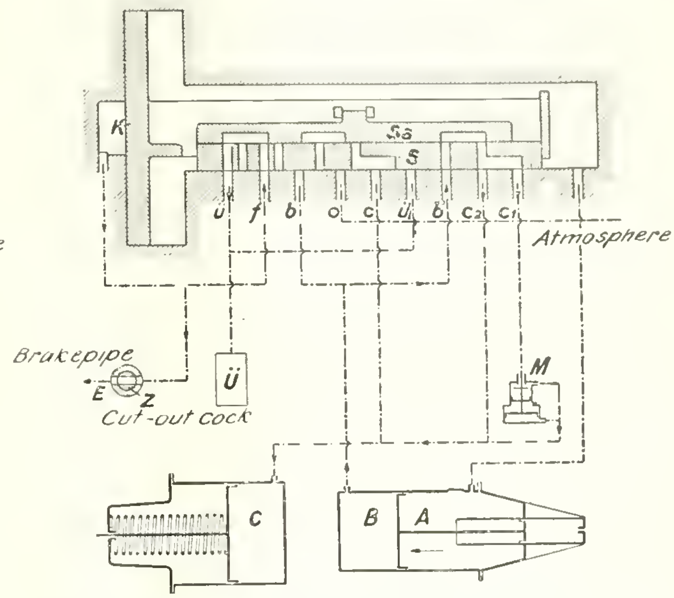


Fig. 7—Diagramatic Arrangement of the Kunze-Knorr Freight Brake, Reducing Valve and Transposing Chamber—Braking Position

The operation of this arrangement is shown in Fig. 8. The two cylinders indicated in the foregoing illustration are shown as made in one piece which corresponds with the actual construction. The differential piston in the *A* chamber is connected with the brake rigging by means of a slotted connection, of such a length, that it only comes into contact with the brake rigging at the end of the stroke when the pressure in *B* and *C* has equalized, and the chamber *A* has fulfilled its main function as a regulation organ. A valve, *V*, placed in the pipe *c2* serves to empty the air out of *B*. A spring-loaded hollow piston valve, which, in the closed position, lies with a hole b_0, in the lower part of its cylinder wall, over an escape opening, leading to the exhaust passage, but in the application position opens under the pressure of the incoming compressed air flowing from *B* through *b* and *c2* and permits the air to flow through *bc* to *C*. When there is an equalization of the pressure in *B* and *C* the valve closes under the influence of the loading spring and the remainder of the air in *B* flows out through the hole b_0 into the atmosphere. Above the transposing cock there is also a passage *c2* and this is open, when in position for an empty car. This brings it about that the highest brake pressure will be reached on both the loaded and empty cars in practically the same length of time.

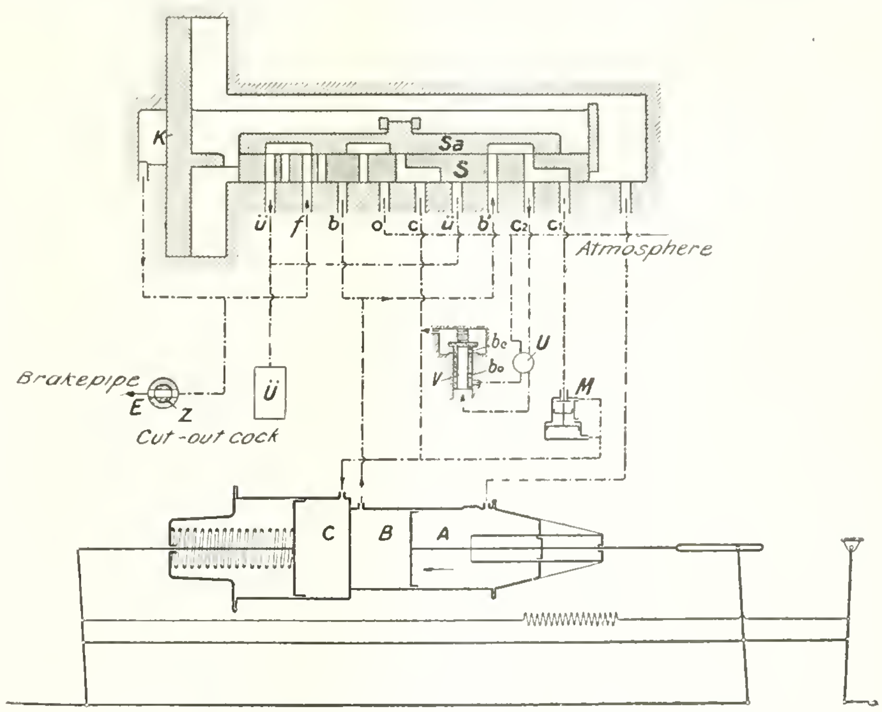


Fig. 8—Diagramatic Arrangement of the Kunze-Knorr Brake, Reducing Valve and Transposing Chamber With Brake Arrangement—Braking Position

Naturally, by placing the transposing valve in the proper position it is possible to obtain only two maximum brake pressures, one for an empty and one for a loaded car. This, then, serves for a perfect operation, from which it will be seen, that naturally the difference between the unbraked cars is still greater.

The brake equipment of a vehicle fitted with the Kunze-Knorr brake consists of the following principal parts:

The *brake cylinder H* with the auxiliary reservoir *A1* and the brake rigging.

The *triple valve G* with the shut-off cock *Z* and the transposing cock *U*.

The transposing mechanism with the two hand cranks.

The brake cylinder release mechanism.

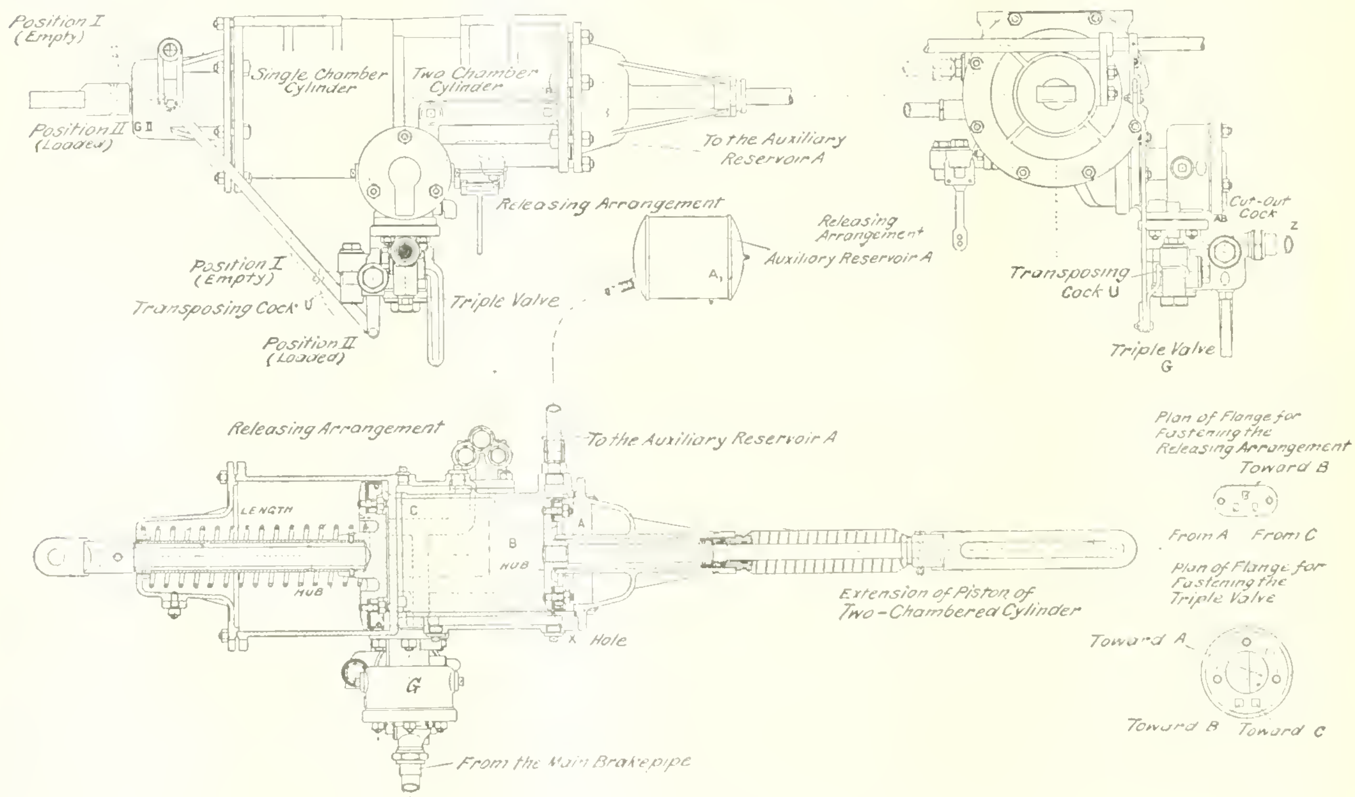
The main brakepipe *E* with the coupling details and the emergency arrangement.

The brake cylinder of the Kunze-Knorr freight train brake has a double cylinder and for all kinds of cars of whatever kind and construction. It consists of a single chambered cylinder of 280 mm. (11 in.) diameter with a working cylinder *C* and a second cylinder of 210 mm. (8.27 in.) diameter with a fore chamber *B* and a working chamber *A* whose volume is made to correspond to a certain definite size by means of a special air reservoir *A1*. Both cylinders are combined in a single casting. The single cylinder piston is a two-part disk piston with a leather packing, with a loose piston rod, a shell guide in the form of a tube like that of the Knorr single chamber cylinder and a counter pressure spring. The two-cylinder piston is also a two-part disk piston with leather packing, with a solid piston rod to which the small counteracting piston is also attached and without a counter pressure spring. When the brakes are in the release position against a stroke of 200mm. (8.66 in.) of the single-chambered cylinder. The two equalizing levers to which the braking pistons are attached are connected together through a common connection rod with a third vertical equalizing lever, for the reversal of the line of pull. From the equalizing lever the brake pull is carried in the usual manner through the foundation brake rigging, the vertical brake levers and the triangular brake-beam to the brakeshoes. The counter pull is taken by a fixed point to which the end connection of the brake rigging is attached.

The principal parts of the triple valve of the Kunze-Knorr brake, as well as the brake cylinder in its assembled form and size, consists of:

The main triple valve piston *K* with the main slide valve *S*, the riding slide valve *Sa*, the loading piston, in addition to which there is the transposing chamber *U*, all of which are in the upper housing which includes the fastening flange.

The bleeding cock *Z*, with the brakepipe connection,



General Arrangement of Brake Cylinders, Kunze-Knorr Brake

both brake pistons are at the right hand end position; in which case the fore cylinder *B* and the working cylinder *A* of the two-chambered cylinder are connected with each other through the hole *x* in the cylinder wall above the triple valve.

The triple valve is placed at the bottom in the center between the one- and two-cylinder position and near the separating flange. Upon the other side of the two-chambered cylinder, the release arrangement is placed.

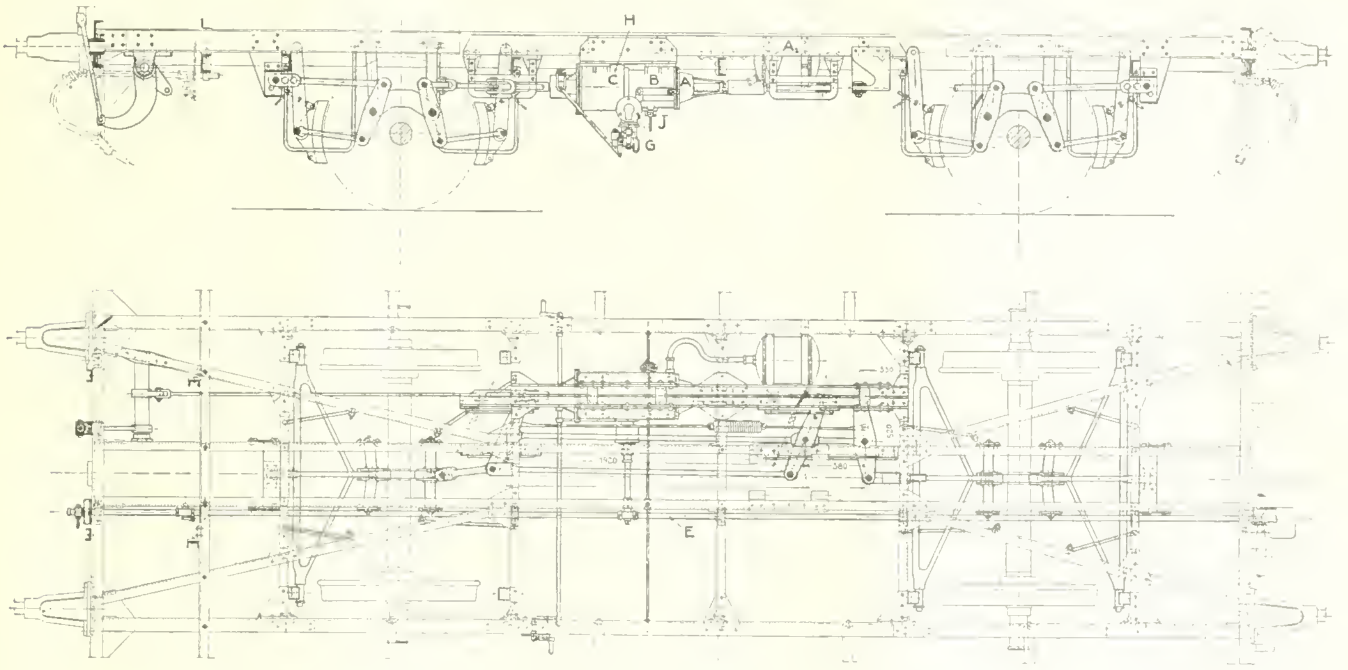
Each of the two brake pistons works the brakes through a special equalizing lever of the brake rigging; the single-chambered cylinder piston pushing and the two-chambered piston pulling. In order that the single and two-chambered pistons may be able to work independently of each other, the end of the two-chambered piston rod carries a slot in which the rigging bolt has a play of 50 mm. (1.97 in.). Corresponding to this advance stroke of the two-chambered piston, the two-chambered cylinder has a stroke of 270 mm. (10.63 in.) as the transposing cock *U*, the pressure reducing valve *M* with the differential piston and the valve *V* which are contained in the lower housing. A small distributing slide valve *Sa*, loosely connected with the stem of the triple piston *K*, moves over the back of the main valve *S* as a cut-off valve.

After drawing the piston *K* out of the triple valve chamber, the main valve *S* and the distributing valve *Sa* can be taken out of the frame-shaped piston rod. In order to prevent the main and distributing valve from falling out when the piston is removed, the main valve *S* rests, while the piston is being drawn out of the triple valve chamber, upon a lug cast to the piston on the side towards piston, while upon the other side it rests upon projection jutting out in the frame of the piston stem. By pushing the piston into the triple valve chamber, the main valve is lifted off from these supports and rests freely upon the valve seat. The distributing slide valve *Sa* is held at the sides by pins set in a corresponding swell of the piston stem frame, so that the distributing valve will partake of every movement of the piston without any play. In order to insure that the distributing valve may be put back in the proper position of its original construction in any reassembling of the same, the two operating pins are made of unequal diameters. The purpose of the loading piston with a ball-shaped cap that is built into the distributing valve *Sa*, is to prevent the chattering or lifting of the valve, if there should be no pressure in the triple valve chamber, when the valve is first being charged.

The result of which would be that, by the passage over the valve from the application to the release positions, a connection would be made from the brakepipe to the space beneath the piston. The transposing chamber, which at the beginning of a brake application takes in air from the brakepipe, contains cup-shaped pistons and a distributing slide valve chamber and has a contents of about 0.4 litre (24.4 cu. in. or a little less than a pint).

pressure, while the space between the two pistons, on the other hand, is always open to the atmosphere. The described form of the reducing valve is taken from the old Knorr freight brake and has, like it, for its purpose the making of an application of the brake with the greatest possible rapidity, but to a slight degree at the start, by causing a flow of compressed air through a large section into a single brake cylinder.

The valve V is back of the distributing valve in the passage leading from the B-chamber to the single cylinder and is shown as formed of a hollow piston having two holes, which are placed in two different planes in the hollow piston. When the valve V is closed the lower hole registers with a passage in the housing, and when the valve is opened the upper opening is freed and thus connects the space within the piston with that above the valve. The spring loading insures the closing of the valve when the pressure on the two sides of the valve have become equalized.



Arrangement Beneath Frame of Freight Car With Kunze-Knorr Brake

The stop cock Z has two positions. In the position when the handle is turned down the brake is cut in, in the other position when the handle is turned sideways the whole brake apparatus is cut out and the car on which it is located then runs as a car carrying a brakepipe only.

The transposing cock U is a multipleway cock and can also be placed in two positions, but has through opening in two planes. In one plane there are two holes crossing each other at right angles, the one of larger and the other of smaller diameter; in the second plane there is a passage of segment-shaped section. By means of the transposing cock the whole of the brake apparatus upon a car can be placed in the empty or loaded position, and when the lever stands horizontally it corresponds to the empty position, and when it is turned down vertically, that position corresponds to the one suited for a loaded car.

The reducing valve M is a cone-shaped valve with wing guides and a light spring loading, and which will be prevented from being forcibly closed by its connection to the different piston. The spaces above the small and below the large pistons are in connection with each other, and are also at all times subjected to the same

Union Membership on the Railroads

According to reports of the Interstate Commerce Commission and reports made by various railway labor unions to the Canadian Department of Labor, the membership of railway labor unions in this country and Mexico totals 1,200,898, and is made up as follows:

Locomotive engineers	82,000
Locomotive enginemen and firemen	104,000
Maintenance of way and railroad shop laborers	163,000
Railroad signalmen	10,891
Railroad stationmen	1,568
Railroad telegraphers	67,600
Railroad trainmen	162,554
Railway clerks, freight handlers, etc.	146,000
Railway conductors	54,583
Switchmen	8,702
Railway employees Dept. American Federation of Labor (estimated)	400,000
Union employees	1,200,898

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The Properties of Cast Iron Car Wheels

It would be difficult to exaggerate the value and importance of the investigation into the properties of cast iron car wheels, conducted under the auspices of the Association of Manufacturers of Chilled Car Wheels and the Bureau of Standards and the University of Illinois, an abstract of whose last bulletin of the series is published in another column of this issue. This completes a work that has been in progress for a number of years and goes as far as it seems possible in purely laboratory work. The Bureau of Standards, an abstract of whose bulletin, No. 209, was published in RAILWAY AND LOCOMOTIVE ENGINEERING for June, 1922, made its investigation from a purely thermal point of view. Its method of procedure was an example of careful simplicity. It consisted of wrapping the wheel in a heating band, raising the temperature of the rim and noting the differences in temperature between it, the plates and the hub, and measuring the strains set up as a result thereof. In addition to this test pieces were cut from the wheels, subjected to the investigation from which the moduli of elasticity were determined. In one of the tables of their bulletin the moduli and strains were translated into stresses per sq. in., and these were found to range from 14,000 lbs. to 28,400 lbs. per sq. in. These were produced by differences in temperature of 289 degs. and 468 degs. Fahr., respectively, between the rim and the hub, while much higher differences rising to 509 degs. produced a lower stress than the maximum above noted. It was found that the difference of but 289 degs., with the resultant stress of 14,000 lbs. per sq. in., was sufficient to crack that particular wheel. Hence it may be fairly assumed that should a differential of 300 degs. exist there would be danger of cracking the plates. Not that it would be sure to crack as one which withstood a temperature differential of 509 degs. without failure. But the variable strength of cast iron, and the impossibility of determining its character, would make it advisable to place the possible danger point of breakage at a differential of 300 degs. Fahr.

At the University of Illinois the work was of a more elaborate character and an attempt was made to make a laboratory reproduction of service conditions. An examination of the various abstracts that have been published in this journal will show that there was an earnest attempt to have the severity of the task fully equal to or greater than the conditions imposed by service; and, as far as laboratory tests can go, they did all that was possible.

The last bulletin, No. 135, was devoted to braking effects, which included the coefficient of friction and the wear of brake shoes. The main point, however, was the effect of brake applications on the wheels themselves. This is expressed in tabular form by a representation of the strains induced in the plates. The precautions against error of measurements in this respect were very complete and the results can be accepted as correct. In this it was natural to expect that the radial strains would be the ones that would have to be taken into account, but it comes as something of a surprise to learn that the tangential strains in the plates are practically negligible. The one unfortunate thing is that the whole expression of the brake shoe effects is in strains, whereas most engineers think in stresses. An attempt will be made in a later article to make the proper transposition and give an approximate idea of the stresses induced.

No wheels were cracked in these tests by the heat caused by the brake application, although, as will be seen by an examination of the tables, the difference of temperature between the outer and inner portions of the plates was, with ten exceptions, greater than the 300 degs. Fahr. which we have taken as within the danger zone on the basis of the investigations of the Bureau of Standards; while, in one case, the difference was more than 600 degs. Fahr. Under the conditions of the Bureau of Standards these differences would almost surely have caused plate cracking. The probable reason for the failure to crack lies in the inequality of the heating. It appears that red hot spots would appear in the tread, hold for a time and disappear; then other spots would appear in other places. This may have caused a high local difference, but with cooler surrounding metal, the stresses in the hot part were prevented from breaking the plate. Car wheel heating in service is such an exceedingly complex matter that it is difficult to foretell events.

For example, it was brought out at the hearing on power brakes before the Interstate Commerce Commission that on one occasion an attempt was made to construct a curve of heat radiation from a heated car wheel by measuring the temperature of the rim at brief intervals after stopping until it had appreciably cooled. The attempt was a failure because the brakes had been partially released before coming to a stop, and there had been a surface cooling of the tread. Then, after the stop, the heat of the interior came to the surface, with the result that ten minutes later that surface was hotter than at the moment of stopping.

Evidently we have not yet learned all that there is to be known about the effects of brakes on car wheels, and it is to be hoped that these investigations will be continued upon wheels in service. The point developed in connection with the coefficient of friction that is of particular interest is the fact of the checking with previous investigations as to effect upon it of pressure and speed. In addition to this it was found that the coefficient was greater on chilled cast iron than on steel wheels, and that the brake shoe wear was greater on steel than on the chilled wheels, both matters of interest, from the standpoints of train control and economy of operation. And finally the report calls specific attention to the fact that the value of the coefficient of friction was practically the same at the end of a two hours' application as at the beginning of the test.

The Association and the University are to be congratulated upon the manner in which this work was done, and the railroads are indebted to them for a mass of valuable information that until the issuance of these bulletins was not available.

The Kunze-Knorr Brake

There appears in another column a description of a new comer into the air brake field, that was developed in Germany and has taken root in Sweden, but it is not known to be in use elsewhere.

In reviewing the brake from the standpoint of practical operation the first point to attract attention is its dependence, for the proper action of the triple valve, on the tightness of the packing of the piston, that moves in what is called the two chambered cylinder, as well as that of the small counterbalancing piston, while that of the main piston in the single chambered cylinder has an influence upon it. The movement of the triple valve piston in making the delicate adjustments between full release and application positions and the corresponding lapping of the valve, depends upon maintaining the desired ratios between the pressure in the back chamber of the two-chambered cylinder and the brakepipe.

If the piston packings are tight, the pressures in the two chambers of the two chambered cylinder, that serves as an auxiliary reservoir, should always be the same, barring the difference that must exist in order to overcome the frictional resistance of the piston, so that, as a matter of fact, the pressure back of the piston must always be greater than that in front of it.

Let us see what effect two leaky piston packings would have.

When there is an application of the brakes the pressure in the back chamber is depended upon to govern the movement of the triple piston back to lap position, and this by its fall below the brakepipe pressure. Now, if there is a leak past these two pistons, whereby the pressure in the back chamber is depleted by the flow of the air into the atmosphere, the triple will return to its lap position and then to full release when there is no increase of brakepipe pressure. This would serve to recharge from the brakepipe, lowering its pressure and increasing the application on other cars, while bleeding itself through the repeated applications and releases on the car with the leaky packings. Or if the packing of the counterbalancing piston leaks so as to reduce the pressure in the auxiliary reservoir below the brakepipe, it will first cause the triple valve to move to the release lap position and then to full release position. This will tend to first deplete the auxiliary and recharging reservoirs, then the brakepipe and these tend to increase the brake-cylinder pressure on cars having tight packings.

It is surely a frail reed to lean upon that of placing dependence, for the proper functioning of the triple valve, on the tightness of three leather packings, two of which are exposed to atmospheric influences.

These are points that must be taken into consideration in reviewing the new system.

The empty and load feature resembles the brake performing similar functions in this country in that both introduce an additional cylinder in order to increase the brakeshoe pressure. The German brake, however, does not come into action under the ordinary conditions of braking, but waits until after a full application has been made with the single cylinder portion of the apparatus, and then enters into action as a supplement thereto.

There is a special device for so regulating the brake cylinder pressure that the ratio between brakeshoe resistance and wheel and rail friction shall be constant.

A careful study of the details of the mechanism in which assistance was rendered by an engineer conversant with the working of the brakes in Sweden, leads to a further criticism of the functioning of the apparatus in itself.

For example, there is a passage or groove in the two-chambered cylinder past the piston, when it is in release position through which the auxiliary reservoir is charged. The first movement in application causes the piston to move over and close this passage so that no further supply of air can reach the auxiliary reservoir except that which may leak back past the piston to make up leakage past the counterbalancing piston. All of this leakage tends to hasten the equalization of the pressures in the fire chamber of the two-chambered cylinder and the single brake cylinder. Then as soon as equalization occurs on any car of the train, the next brakepipe reduction that occurs will produce an emergency application.

It must be borne in mind that this equalization is dependent upon the length of piston travel; the shorter the travel the sooner the equalization takes place and the sooner an automatic emergency application is apt to occur.

This is especially dangerous with this brake because there is no means of exhausting the brakepipe directly into the atmosphere locally, as with our quick action triples, but the brakepipe reduction and exhaustion must take place through the engineer's valve. This means a slow propagation of serial emergency brakepipe reduction with all of its attendant dangers.

This influence of piston travel in causing an automatic emergency application is of vital importance, in that it means that it may occur spasmodically on any portion of a train where piston travel happens to be shorter than elsewhere.

Again, on release, the equalization of these two spaces may charge the auxiliary reservoir just as the present *L* type triple valve charges the auxiliary reservoir from the supplementary reservoir and a direct release will result.

When operating in graduated release, the action of the triple valve in lap position is dependent upon the ability of the pressure released from the charging reservoir into the fore chamber to move the piston back by an amount sufficient to build up the necessary pressure required in the valve chamber of the triple valve to move its piston against the brakepipe pressure on the other side of it. It is evident that if the piston packing leaks a greater travel will be required in order to obtain the compression required. At the same time the retracting spring and the counterbalancing piston will tend to gradually carry the large piston home, and the moment it uncovers the leakage groove, the pressure in the charging and auxiliary reservoirs will equalize, the graduating feature will be lost, and the brakes will be completely released before the brakepipe pressure is completely restored.

We have seen that the maintenance of its graduated release is neither positive nor uniform and that it is in danger of a loss of braking power unless it can be recharged to an even greater extent than our own brakes because of the possibility of the auxiliary reservoir leaking to the atmosphere; so that prolonged braking periods are impossible, because there is no means of replenishing its two reservoirs except the usual one of fully releasing to recharge.

Taken as a whole it is difficult to see how it offers any advantages over our brakes, with which it is identical in many respects.

It possesses the quick recharge of the reservoir from which the braking power is derived as in the *L* triple. The graduated release is also similar to the same triple in that the recharging reservoir may be taken to represent the supplementary reservoir of the *L* equipment, and it is discharged into the auxiliary reservoir in proportion to the increase in brakepipe pressure, and in both cases graduated application and graduated release will deplete the reservoirs.

The difference between the two lies in the functional operation. With the *L* triple, the supplementary reservoir air flows to the brake cylinder, in an emergency application with the auxiliary reservoir, thus producing a high emergency brake cylinder pressure in one cylinder. With the German brake, a second cylinder is used instead of an increased brake cylinder pressure.

This description and review is given because of the attention that the new brake has attracted, but it does not appear that it possesses any real advantage over the brakes that are in use in this country.

A Two-Edged Sword

A two-edged sword is one that cuts both ways, and this principle is susceptible of application to problems other than on the field of battle.

The efficiency engineer, or expert investigator, is not always received in open arms by those whom he is assigned to investigate, although as a rule he can retain the respect and confidence of most all those interested, unless there be some who deserve criticism or censure and are too narrow to recognize their error.

Of the numerous instances of difficult problems of this nature requiring patience and tact, one stands out as having unusual features in that the expert, while devoting his time and energy toward one particular end, unconsciously accomplished equally as much in an entirely opposite direction, cutting as it were like a "Two-Edged Sword."

Unfair Use of Railway Property

The president of a large manufacturing concern, with ample rail connections for both incoming and outgoing traffic, decided to have an investigation made of the company's affairs by an outside or neutral expert with a view of learning from one not connected with their policies whether there was room for improvement, and if any economic leaks were found, to stop them.

The works manager, in direct charge of and responsible for the entire plant, did not take kindly to this, considering it a reflection on his ability.

The expert went to work however, evidently with the intention of locating something that would justify his employment even in a fairly well regulated institution, and in a few days he reported to the president that he had found an item of several hundred dollars per year paid out as demurrage on freight cars, with many cars standing idle under load awaiting to be made empty, and plenty of labor available for unloading, but that the vice-president was evidently asleep on matters of this kind, whereupon, the president called a conference, and in asking for an explanation, reminded the works manager that he had not even asked for an appropriation for additional store or warehouse facilities, to which the resourceful works manager made the following reply:

"It is true I have not asked for additional storehouse buildings, first, for the simple common sense business reason that owing to the high cost of material and labor, their cost would be about $15,000 to $20,000 on which the interest charge at 6 per cent would be about $1,000 per year; and second, I don't want any additional storehouse facilities for the simple reason that our raw material is of a character that is not only expensive to handle, but depreciates in handling, and our net profits on finished product, or factory cost is much lower by taking this raw material direct from the car with *one* handling direct to the point of fabrication, than when unloaded to a store or stock room and then again rehandled to point of fabrication, so that the item of around $400 to $500 per year paid for demurrage on freight cars is a mere bagatelle, when compared with what I save by leaving this material in the cars until I am ready to run it through the plant into a finished product, practically with one continuous handling."

The Works Manager's explanation was accepted for the time being, as the balance sheet or factory cost fully supported his position, but the president could not reconcile the idea of being dependent upon the punctuality of rail shipment, with good business judgment, even though the net profits from manufacturing were for the time greater. Then, again he found, on investigation, that outbound shipments of finished products were badly delayed, resulting in some cases with loss of valuable orders, and that one of the reasons was lack of cars, the railway officers explaining that their failure to supply cars was due largely to the unbusinesslike or pernicious custom of thousands of their patrons using cars for auxiliary storehouses, absolutely disregarding all requests or complaints to unload, so that the equipment might be kept in the service for which it was built, and that this particular company was one of the worst offenders in contributing to a general car shortage or famine, at a time when the railroads could have met most all reasonable demands had they not been hampered by those who should have aided them.

The result was a complete change in policy embracing the following:

(a) Ample storehouse facilities for current or surplus stock of raw material.

(b) The immediate unloading of all shipments, and railway company to be notified car is waiting.

(c) Prompt loading and billing out of all outbound shipments.

By this plan what had been an incomplete or unfinished manufacturing plant was finished by proper additions which is a capital charge and should never have been omitted.

The demurrage item was minimized to the vanishing point, and the works manager found ways and means of turning out a finished product without the partial use of railway property, which is railway capital, and the railways were able to furnish *more cars* and *more* transportation. And finally, the initial effort of the neutral expert to reduce demurrage charges as an item of operating expense, resulted in greater advantages in other matters that were fundamental in any well regulated business.

Truth is Mighty and Will Prevail

Doubtless many mistakes have been made by railway managers, and owing to the magnitude of the industry of transportation others will be made in future, but it may safely be stated as a general proposition that the number of errors and their effect on those concerned is *less* in proportion to the interests involved than in any other line of human activity. In other words, the doctrine of "A Square Deal" prevails to a greater extent in railway management than in any other business, yet in the face of this well known fact the anti-railway propagandist is as busy as though there were actually some good reasons for his existence.

One lamentable feature of the presence and baneful effects of the propagandist activities on the public mind is the fact that many of them are employes of the railways, earning their living and raising families on the compensation from the railway treasury, and although receiving the highest pay and best treatment ever accorded railway men in this country, or in the whole world, yet some few of them are so ungrateful as to turn to bite the hand that feeds them.

In a recent issue of a labor organization paper is an article severely arraigning two of our leading railways on the question of expenditures, making comparisons and drawing conclusions, that to anyone fairly well informed on the subject were so manifestly at variance with the true facts as to be in substance base falsehood.

That the public is, and has been for some time, liberally fed up on this kind of rot from the enemies of railway interests is well known, but on just what hypothesis any loyal employe or fair-minded labor leader would endorse such statements it is hard to understand, for in the last analysis the true facts, which are now available to all, will come out to mock or haunt those who are responsible for such acts of ingratitude. "Truth is mighty and will prevail."

Program for Improvement in Railroad Service

After a meeting of the member railroads of the American Railway Association and the Association of Railway Executives held in New York on April 5, the following announcement was made relative to the plans of the railroads for the improvement and betterment of transportation conditions throughout the country:

Anticipating the greatest volume of freight traffic this year in their history, the railroads today adopted a concerted policy and intensive working program to enable them to meet the growing transportation needs of the country.

This program was set out in a resolution based on recommendations submitted in a report of the Car Service Division of the American Railway Association.

Despite the obstacles placed in the way of transportation service since July 1, 1922, by the cumulative effects of the coal miners' and shopmen's strikes, the railroads here, between July 1, 1922, and March 17, 1923—a period of 37 weeks—handled the greatest volume of traffic ever transported during any corresponding period in the history of the country.

In full realization of the necessity for the greatest improvement and expansion possible of the country's transportation facilities to meet the growing demands of commerce, the railroads have authorized since January 1, 1922, for cars, locomotives, trackage, and other facilities, the expenditure of $1,540,000,000, of which $440,000,000 was actually expended during the year 1922.

The railroads of the country are raising this enormous amount of additional capital largely through borrowed money on the abiding faith in the fairness of the American people and reliance on the continuance of the policy announced in the Transportation Act of 1920, as a measure of reasonable protection to investment in railroad property.

New Equipment Bought

From January 1, 1922, to March 15, 1923, the railroads purchased 223,616 new freight cars Of these 117,280 have been delivered and put in service. The railroads during that time also purchased 4,219 new locomotives. Of that number 2,106 have already been placed in service. Practically all the equipment still on order is to be delivered by Fall, at which time freight traffic is always the heaviest. Subsequent orders for additional cars and locomotives are constantly being placed.

The program adopted by the American Railway Association and approved by the Association of Railway Executives follows:

1. That by October 1, 1923, when the peak movement ordinarily begins, cars awaiting repairs be reduced to the normal basis of 5 per cent. of the total equipment of the country.

2. That by October 1, 1923, locomotives awaiting heavy repairs be reduced to a normal basis for the entire country of 15 per cent.

3. That to the extent coal is stored for railroad use complete the storage requirements by September 1 so that after that date the equipment and other transportation facilities may be used to the greatest extent for commercial coal necessities.

4. That the use of power and equipment for railroad construction and maintenance purposes be restricted to the minimum after September 1 in order that a maximum of power and equipment may be available for commercial purposes.

5. That railroads in producing and consuming sections impress upon all interested the necessity for movement of coal and ore via the lakes in the largest possible quantity early in the season. That railroads serving upper lake ports carry on a campaign for early purchase and shipment of coal from the upper lake docks to points of consumption.

6. That an effort also be made to bring about the prosecution of road and building construction work as early in the season as possible in order that equipment may be available for larger movement of seasonal commodities.

7. That all interested be impressed with the necessity for loading all cars to maximum capacity in an effort to bring the average loading to 30 tons per car for the entire country; for unloading cars promptly; increasing storage facilities where necessary and providing adequate siding capacity to facilitate loading and unloading, thereby increasing the number of available cars.

8. That every possible means be adopted to increase the mileage per car per day to an average of 30 for the entire country, particular attention being given to prompt movement through terminals and yards and to the issuance of embargoes when necessary to prevent congestion.

Control and Distribution of Cars

The railroads have already established and have in active and effective operation a comprehensive organization in the Car Service Division for the central control and distribution of freight cars which, during recent periods of car shortage, has under difficult conditions secured to the public the best possible use of available freight equipment.

The freight car repair program is to be prosecuted with a view to conditioning for grain and grain products movement, which showed a particularly noticeable increase last year, the largest possible number of box cars, and extraordinary measures are also to be taken to reduce the number of refrigerator cars awaiting repairs to the lowest possible limit.

The effective cooperation of shippers during recent years has helped to lift American railroad performance to higher levels. At this time the railroads bespeak an even wider cooperation on the part of the public. It can assist by storing coal during the Spring and Summer months in anticipation of Fall and Winter requirements to as great an extent as possible. Everybody can help by looking forward. Every shipment which by foresight can be dispatched during April, May, June, or July, will help to decrease any congestion in September, October, or November. Every shipper who will load cars to capacity and every consignee who will promptly unload cars will by so doing save the equivalent of many cars for the benefit of all shippers.

This appeal is made with full recognition by the railroads of their own responsibility for prompt movement of loaded or empty equipment as being one of the primary measures necessary to avoid waste of transportation. The railroads in the carrying out of their program confidently look forward to the successful movement of the largest volume of traffic in the history of the country and pledge their best efforts to that end.

Chamber of Commerce to Discuss Transportation

"Transportation in All Its Phases in the United States" and "Europe and Europe's Affairs" will be the two major topics considered at the eleventh annual meeting of the Chamber of Commerce of the United States in New York, May 7 to 10.

Because of the interest of business men through the country in the two general subjects it is expected that the convention will be one of the largest ever held by the Chamber. Representative business organizations in every State in the Union have been asked to send delegates, and an attendance of from 4,000 to 5,000 business men is looked for.

Transportation will be the keynote of the meeting as it is the keynote of virtually every business discussion over the country these days. Already the National Chamber is engaged on a comprehensive study of the whole problem from every point of view, hoping to aid in the ultimate formulation of a national transportation policy. That study, however, has been intrusted to a Transportation Conference created by the National Chamber and its conclusions will not be available for months in all probability. Special committees of the conference, dealing with specific divisions of the general question, will be in session at the time of the annual meeting and the discussion of transportation subjects at the meeting in New York naturally divides itself into lines similar to the committee work of the conference.

Representatives of railroads, shipping interests, producers, the motor industry, waterway operators and the public are included in the conference make up and also will be heard before the annual meeting. The aspects they will discuss at the meeting include governmental relations to transportation, railroad consolidations, rate schedule readjustments, coordination of motor transport and waterway carriers.

Into the European division of the annual meeting program fall such questions as reparations, war debts, currency depreciation and others which recent developments in France and Germany have made of outstanding importance to American business interests. President Julius H. Barnes of the National Chamber and about a hundred American delegates are now abroad to attend the second meeting of the International Chamber of Commerce in Rome. They will return in time for the National Chamber meeting in New York, however, and bring first hand impressions of the European situation to their colleagues.

Annual Meeting of the Mechanical Division of the American Railway Association

An announcement has been sent out by the secretary that the regular annual meeting of the Division will be held at Orchestra Hall, 220 South Michigan Avenue, Chicago, Illinois, Wednesday, Thursday and Friday, June 20, 21 and 22, 1923.

The business before this meeting will be consideration of, and acting upon the reports of the following committees:

General Committee.
Nominating Committee.
Arbitration Committee.
Committee on Brakes and Brake Equipment.
Committee on Car Construction.
Committee on Couplers and Draft Gears.
Committee on Design of Shops and Engine Terminals.
Committee on Electric Rolling Stock.
Committee on Loading Rules.
Committee on Locomotive and Car Lighting.
Committee on Locomotive Design and Construction.
Committee on Prices for Labor and Materials.
Committee on Safety Appliances.
Committee on Specifications and Tests for Materials.
Committee on Tank Cars.
Committee on Wheels.

In addition to the reports of the above committees, individual papers will be presented on the following subjects:

The Development of the Locomotive, by Mr. Samuel Vauclain, President, Baldwin Locomotive Works. The Development of Railway Cars, by Mr. E. F. Carry, President, The Pullman Company. Increasing of Locomotive Mileage, by Mr. C. F. Giles, Superintendent, Machinery, Louisville & Nashville Railroad Co. Training of Apprentices and Supervising Foremen, by Mr. John Purcell, Assistant to Vice-President, Atchison, Topeka and Santa Fe Railway Co.

In addition, opportunity will be given for a free discussion of the following general subjects: Cooperative Research, Economies from Modern Shop Machinery, Handling of Material on Car Repair Tracks, Modern Repair Track Facilities, Possibilities for Increased Efficiency of Modern Locomotives, Shop Management Problems of today.

The meeting will be addressed either personally or by papers, on interesting subjects by the following Railroad Executives: R. H. Aishton, President, American Railway Association; W. W. Atterbury, Vice-President, Pennsylvania System; C. H. Markham, President, Illinois Central Railway; W. B. Storey, President, Atchison, Topeka & Santa Fe Railway; Sir Henry Thornton, K. B. E., President, Canadian National Railways. This will insure a presentation of topics of vital interest to the railway men and the public generally, by men who are especially well qualified to handle the subjects assigned to them, and which will be announced later.

The meeting will be called to order promptly at 10.00 a. m. Wednesday, June 20th. The sessions will continue all day, each day, opening at 9.30 a. m. Thursday and Friday, the 21st and 22d.

Registration of attendance will be taken at each session.

A cordial invitation is extended to those actually connected, either in official or advisory capacity, with the subjects presented.

New Electric Locomotives For the Norfolk & Western R.R.

Features Include Cab Structure Carried By Side Frames—Four Pairs of Drivers in Single Truck Per Cab—Single 1,000 Hp. Motor Per Jack Shaft—Oil Insulated Force Cooled Transformer—Unique Arrangement To Reduce Torque on Any Motor To Prevent Slipping

By T. C. Wurts, General Engineer, Westinghouse Electric & Manufacturing Company

In the winter of 1913-1914 electric operation was started on the Elkhorn Grade Electrification of the Norfolk and Western Railway Company. The locomotives used were of the Baldwin-Westinghouse "split-phase" type, of a design yet untried, the electrical functioning of the locomotives being such that single-phase current of 11,000 volts was collected from the trolley and transformed inside the locomotive to three-phase current at a voltage suitable for the induction type traction motors.

Twelve of these locomotives, when placed in operation, retired thirty-three huge mallet type steam locomotives, and in the opinion of the railway company's operating officials have more than doubled the capacity of the road. In addition, the operating savings have been such that the company has realized a very good income from its investment.

Such excellent service has been rendered by these locomotives that the Norfolk and Western Railway Company has recently placed orders for four additional locomotives with approximately thirty per cent greater hauling capacity than those now in operation. Like the previous locomotives, this new unit will consist of two cabs permanently connected to form a locomotive. The equipment in each cab will be identical, so that any two cabs can be coupled together, back to back, to form a locomotive unit.

The principal dimensions of the cab and wheel arrangement are as follows:

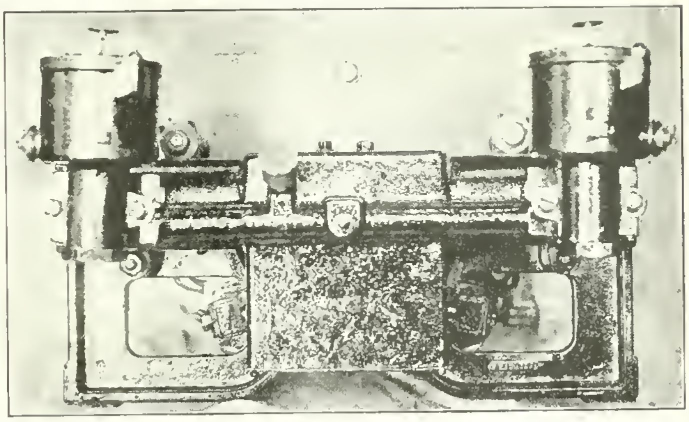
Wheel arrangement	2-8-2 and 2-8-2
Rigid wheel base	16 feet 6 inches
Length over coupler faces	97 feet 2 inches
Total wheel base	83 feet 0 inches
Height from rail to top of cab proper	13 feet 5 inches
Height from rail to top of clerestory	14 feet 9 inches
Height from rail to pantagraph in lock down position	15 feet 10 inches
Maximum width over side sheets	10 feet 5 inches
Diameter of driving wheels over tires	62 inches
Diameter of truck wheels over tires	33 inches

The design of the cab and running gear is the result of the combined study of the railway company and their consulting engineers, Messrs. Gibbs and Hill. It embodies all the improvements thought necessary as a result of the present operation, and is especially designed to meet the very severe service to which it will be subjected. Several unique features are to be noted.

The cab structure is fastened rigidly to and is carried by the side frames. This is contrasted with the previous construction of a cab supported by springs and sliding bearings. The side frames are massive vanadium steel castings connected by cross ties, which are also used to support the heavier pieces of electrical apparatus mounted in the cab. The four pairs of drivers of one cab are in a single truck, whereas two trucks of two pairs of drivers each, connected by a mallet hinge, are used on the previous engines.

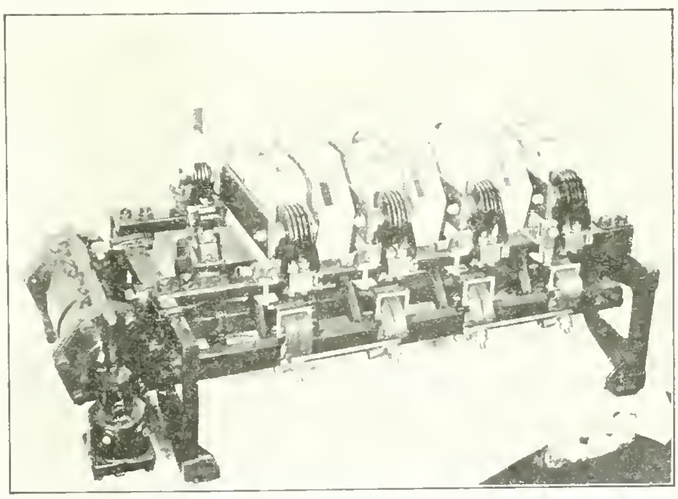
The spring suspension arrangement is of the Mikado type, embodying side equalization between the leading truck and its adjoining two driving axles and cross equalization between the other two driving axles and the trailing truck.

Ease of removal of the jack shaft and its bearing is an outstanding feature of the locomotive. The jackshaft is carried in heavy bronze bearings, split vertically, which rest on a heavy steel casting or collar. These are set in the side frames between very accurately fitted pedestal ways. The collar casting itself is provided with a tie bar arranged so that the collar becomes almost an integral part of the side frame, and in no way weakens the latter's strength. This application follows closely the arrangement on the previous locomotives which has proven very successful.



Cam Switch Group for Starting Auxiliary Motors

The locomotive cabs and mechanical parts are now being built by the American Locomotive Company, and when completed will be shipped to the works of the builder of the electrical equipment and the gearing, the Westinghouse Electric and Manufacturing Company, where the electrical equipment will be mounted and the locomotives tested before shipment to the railway company is made.

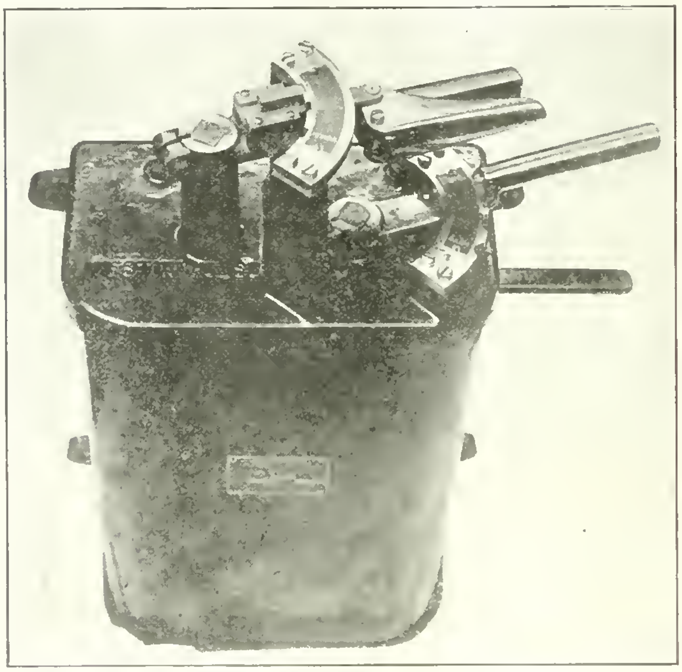


Cam Operated Switch Group for Short Circuiting and Secondary Windings of the Traction Motors

A flexible gear mounted on each end of the jack shaft transmits the motor torque by means of side rods to the driving wheels. The springs are inserted without initial compression, and are so designed that they do not become completely compressed until a torque is exerted equivalent to a locomotive adhesion of 110 per cent.

In the design of the main motors the Westinghouse Electric and Manufacturing Company has followed closely along the lines laid down in their design of motors for the experimental split-phase locomotive of the Pennsylvania Railroad built in anticipation of the Altoona Grade Electrification. In the case of the present locomotives, however, but a single motor per jack shaft is provided as compared with two motors per jack shaft on the previous Norfolk and Western locomotives, and on the Pennsylvania Railroad locomotives just mentioned.

Structurally, the motor is of the induction type with a wound secondary arranged so that it can be connected for either four or eight poles, corresponding to locomotive



Master Controller, One of Which Is Located in Each Locomotive Unit

speeds of approximately 28 mph. and 14 mph. respectively. Collector rings are provided to connect the secondary windings to liquid rheostats which provide the starting resistance. These collectors are mounted at the ends of the motor shaft to provide ready accessibility and ease of inspection.

The nominal rating of the traction motors on the one hour basis is 1,000 hp. each. Four motors of one complete locomotive unit are capable of developing a tractive effort of 90,000 pounds continuously at 14 mph., and 52,500 pounds continuously at 28 mph. On a basis of the one hour rating, the tractive efforts developed are 108,000 pounds, and 63,000 pounds at 14 mph., and 28 mph. respectively.

A new and most interesting feature of this locomotive is the use of an Oil Insulated Force Cooled Transformer. The transformer tank is cylindrical in shape with its upper end projecting slightly above the cab roof. The oil insulated type of transformer has been almost universally used in single-phase European electrifications, but up to this time the air blast transformer has been the standard in this country in all trunk line installations.

The phase converter is of the synchronous type. Its stator is wound essentially like a two-phase induction motor. Its rotor is wound for D. C. excitation by means of which the locomotive power factor may be controlled so that at full load it will be approximately 95 per cent. The phase converter is started by means of a small single-phase commutator type motor mounted directly on its shaft, arranged so that when its starting function is completed it is reconnected as a separately excited D. C. generator to furnish the current for the phase converter rotor. Separate excitation for the D. C. generator is obtained from the control generator and the storage battery.

The phase converter stator windings are so arranged that one of them acts as a driving winding for the rotor. The other winding has a voltage generated in it which has approximately a 90 deg. phase relation with the transformer voltage. By combining this voltage with the transformer secondary voltage in accordance with the usual two-phase-three-phase connection, balanced three-phase voltage is produced at the traction motor terminals.

By means of a balancing transformer preventive coil normal motor voltage is maintained with a 15 per cent drop in trolley voltage during accelerating, and with a drop in trolley voltage of half this value during normal running.

Cooling of the oil insulated transformer is accomplished by means of pumping the oil through a force ventilated radiator. A single motor supplies the energy to drive both the oil pump and the blower for the ventilating air.

Ventilation of the traction motors is acomplished by means of a motor driven blower set for each motor. These motors are identical in design to the motor for the combined blower and pump set and to the motor driving the pump which circulates the electrolyte in the liquid rheostat, the only variation being in the shaft extension. This practically accomplishes interchangeability of all auxiliary motors.

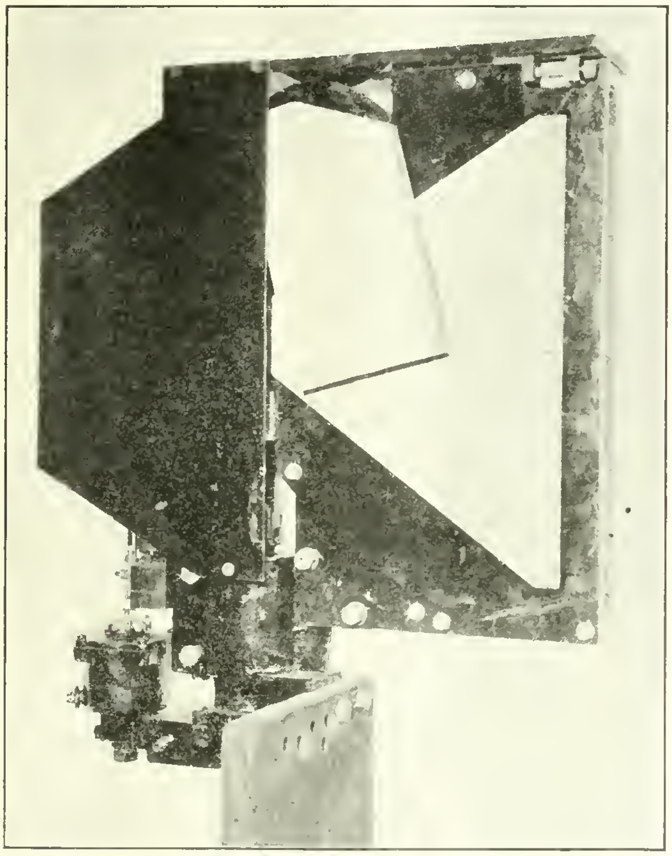
Following highly satisfactory previous practice on the Norfolk and Western Railway, the generator, furnishing the energy for the control, charging the storage battery, and exciting the D. C. exciter for the phase converter is chain driven from the shaft of the phase converter. It has a capacity sufficiently large so that in the event of a control generator failure in the adjacent cab, one generator can furnish the excitation for both D. C. exciters.

In the design of the liquid rheostats the Westinghouse Electric and Manufacturing Company has improved materially on any rheostat of this type supplied heretofore. The rheostats for both motors of one cab are contained in a common tank with a common storage supply. This insures the same elecrolyte strength in both rheostats. By means of a common valve, motor operated, and controlled from the master controller, the electrolyte in both rheostats is raised uniformly and at the same rate. By special arrangement of the control, the movement of the electrolyte valves in two cabs can be so related that an equal division of load on all four motors of one locomotive is assured.

One of the features of the previous Norfolk and Western locomotives was an arrangement of the control whereby, in the event of one of the trucks of a locomotive losing its adhesion, full torque could be maintained on the three trucks holding the rail, while the torque on the fourth truck was reduced until slipping had stopped when the torque of this truck was raised to a value equal to the others and the acceleration continued. This feature was found to be of tremendous value and is one that is incorporated in the control of no other engine ever designed, with the single exception of the experimental split-phase engine built by the Pennsylvania Railroad Company in 1917. Even this feature has been improved upon on the locomotives under discussion. By means of four push buttons located close to the master controller, the engineman can lower the torque on any motor of the locomotive, and on releasing the push button the torque of this motor will be raised to that of the others automatically.

Pneumatically operated cam type switches are used for the arrangement of the traction motor circuits for either the 14 mph. connection or the 28 mph. connection. The control is so arranged that during transition from one speed to the other the torque of only one half the locomotive is momentarily lost while making this change in motor connections. This follows exactly the arrangement now existing on the Norfolk and Western locomotives, which has proved most satisfactory.

A motor-driven air compressor is provided on each cab (two per locomotive), having a displacement of 150 cubic feet of free air per minute against a pressure of 130 pounds per square inch. This motor-driven compressor



One of the Motor Switches

set is designed for continuous operation and has sufficient capacity to charge the long trains commonly operated by the Railway Company. The reservoir capacity per locomotive will be approximately 125,000 cubic inches as an extra safeguard to insure complete charging of long train lines.

The service to be performed by these locomotives is unquestionably the most severe to which any electric locomotive has ever been subject. The traffic consists of heavy tonnage coal trains of 4,200 tons hauled up six miles of 2 per cent grade on a road noted for its curves. The speed of the train up this heavy grade with two locomotives is 14 mph. Acceleration of these huge trains on the 2 per cent grade standing on heavy "S" curves is part of the normal operation and is accomplished with ease. The performance of this type of locomotive has been so remarkable that the operating officials of the Railway Company are enthusiastic in their praise, and more than satisfied with their operation as shown by this recent order for four additional locomotives with 30 per cent greater capacity than those now in operation.

Meeting of New York Railroad Club

At the April meeting of the New York Railroad Club a most interesting and valuable paper was read, entitled, Some Notes on Economics of Railroad Construction, and Maintenance and Operation, by S. F. S. Stevens, engineer of maintenance of way of the Philadelphia and Reading. As the author was unable to be present the paper was read by C. H. Stein, general manager of the Central Railroad of New Jersey.

As the title implies, the paper covered many angles of railroad construction, operation and maintenance, and, in addition, the present and possible future economics. The latter feature brought out in the discussion following the presentation of the paper the views of the leading students of this question.

The probability or even possibility of changing the standard 4 ft. 8½ in. gauge to 5 ft. or more in order to increase present clearance limits, and thus permit of increasing dimensions of equipment, was discussed and the trend of thought was adverse to this question. In the discussion of this phase of the subject it was brought out that the late E. H. Harriman had seriously thought of the advisability of 12,000 to 15,000 miles of six foot gauge in this country, to be used principally for heavy tonnage, through trains of about 10,000 tons between the principal commercial centers.

Fuel Association Organizing Local Chapters

Periodical meetings in the principal railroad centers to stimulate interest in fuel matters is one of the activities recently undertaken by the International Railway Fuel Association. In December, 1922, President J. N. Clark, acting upon authority of the Executive Committee, requested members in some of the larger railroad centers to organize district chapters. This work is now being carried forward and the District of Columbia Chapter, which was organized on January 10, 1923, has already held two meetings. The subjects discussed by this chapter included: Forms of Fuel Contracts; Practicability of Fuel Purchased on Specification Basis; Methods of Fuel Distribution by Direct Consignment from Mines to Coaling Station and Otherwise, and Supervision of Locomotive Operation. The Chicago District Chapter held a meeting on March 12, at which W. E. Dunham, assistant superintendent motive power and machinery of the Chicago & North Western, presented a paper on Cold Weather Practices as Related to Fuel Conservation. Each section will be allowed to work out its own program for the discussion of problems of local or general interest. It is thought that by holding informal meetings each thirty or sixty days the members will be able to promote the best methods for fuel economy in their own territory.

New Equipment for Siamese Railways

A French company has obtained the contract for 10 new locomotives for the Siamese State railways, on the basis of the lowest tender in competition with American, British, Belgian, and German concerns. The total amount budgeted being considerably in excess of the French tender, a portion of the surplus over and above the price quoted was diverted to the purchase of 4 additional locomotives, 2 from an American company and 2 from a British concern. At the present time only British and German locomotives are in use on the Siamest State railways, and the new contracts mark the introduction into Siam of the first American railway equipment of this character.

Strains in Car Wheels Due to Brake Application, Coefficient of Friction and Brake Shoe Wear

Results of Investigation Conducted at the University of Illinois

By J. M. SNODGRASS and F. H. GULDNER

As noticed in the April issue of RAILWAY AND LOCOMOTIVE ENGINEERING, the University of Illinois has issued the third and last bulletin setting forth the results of the investigation as to stresses and strains set up in car wheels, which it has been making in cooperation with the Association of Manufacturers of Chilled Iron Car Wheels.

This particular report is concerned specifically first, with the strains due to brake application, and second, with brake-shoe wear and the coefficient of friction between the wheel and shoe. The strains produced through the application of the brakes were determined in the case of six chilled iron wheels and one steel wheel under the nominal conditions of speed, brake-shoe pressure, and length of run. The operating speeds ranged from 10 to 50 miles per hour, the brake-shoe pressures from 1,000 to 3,000 pounds and the lengths of the run from 10 to 30 miles. The strain measurements taken during the tests were made after stopping the wheel. Data were secured for the determination of the coefficient of friction, the tangential pull, the work done by the brake-shoe on the wheel, and the weight of metal lost by the shoe.

In addition to these, a series of tests was made for the purpose of determining the coefficients of friction and brake-shoe losses for a chilled iron and steel wheel under similar conditions of brake-shoe pressure and speed. In these tests the shoe pressure ranged from 500 to 3,000 pounds and the speed from 5 to 50 miles per hour.

General Effects of Brake Application

The application of a brake to the rim or tread of a car wheel for the purpose of retarding the car produces, through friction between the brake shoe and wheel, localized heating of the tread, which in turn sets up temperature gradients and consequently strains or deformations throughout the wheel. In descending important grades like those of mountainous regions, the speed of a train may be controlled almost wholly by the brakes. When the grade is steep and of considerable length, the amount of energy destroyed by means of friction between the wheel and shoe is very large. This results in high temperatures at the tread of the wheel with comparatively low temperatures at the hub. The differences in temperature between rim and hub thus produced may result in severe strains within the wheel. When operating trains on long descending grades, some roads establish thermal or cooling stations at which stops are made in order to prevent excessive temperature gradients and the consequent strains within the wheels, and further, to allow temperatures to become equalized within the wheels, thereby reducing the strains or stresses already set up. Wheels of trains operating on level track may also be subjected to excessive differences in temperature between wheel rims and hubs through dragging brakes. This condition arises with defective brake equipment, the brakes not releasing as they should. In these cases cars may be moved for considerable distances with brakes either wholly or partially applied, and if the conditions are such that rotation of the wheels continues, the strains set up may be large. The case where the grip of the brakes is such that the wheel is dragged along the rail without rotating does not belong to the present discussion. Defective brake equipment may also cause certain cars to furnish either more or less than their proportionate share of the total amount of retardation required in stopping a train. The wheels under a car that is called on to do more than its share in the retardation may be overheated, and consequently become subjected to severe strains.

In service, the matter of unequal temperatures or temperature gradients arising through long-continued brake application often becomes a serious problem, especially when equipment may not be properly handled by operating men. The abnormal stresses produced may result in broken wheels with the attendant possibility of train wrecks. Examination of wheels broken in this manner generally indicates abuse; and it is impossible to determine, except very roughly, the maximum values of the stresses causing failure, or the weakest section of different types of wheels. Moreover, these inspections of car wheels which have failed do not necessarily disclose the conditions causing failure nor the source of the stresses which may have been most important in producing failure. The tests described herein are largely concerned with the determination of the strains that may be produced within wheels through brake application and consequent heating at the wheel tread. Strains produced by mounting the wheel, by imposed car loads, by flange pressure, shock, or impact, such as occur in service are excluded from this report. A determination of the strains produced by heating which is caused by brake application, should be helpful in studying abuses resulting from severe braking, and in solving problems connected with the design and operation of brakes.

A considerable amount of data relating to brake-shoe wear and the coefficient of friction between brake-shoes and chilled iron wheels was obtained in connection with the tests to determine the strains in the several wheels. A few data of similar nature were also secured for the steel wheel.

This material, which has been summarized, is presented in tabular form.

Some additional tests were made to determine the relative values of the coefficient of friction and the shoe wear on steel and chilled iron wheels, respectively. These tests were confined to the range of shoe pressure and speeds found in ordinary freight service.

Car-wheel friction tests as a rule are made for the purpose of determining the average value of the coefficient and the shoe wear in stopping the wheel from some predetermined speed. The special coefficient of friction tests here differ therefrom in that friction and wear were determined with the wheel rotating at a constant speed. In these tests the same brake shoe was used throughout on comparative studies of a chilled iron and a forged steel wheel under identical test conditions, in which the shoe pressure ranged from 500 to 3,000 pounds and the speed from 10 to 50 miles per hour. The tests were made with a brake shoe testing machine. To prevent overheating, the brake-shoe, after having been applied to the wheel for a number of revolutions, was raised for cooling. At 5 miles per hour the cycle consisted of approximately 190 revolutions of the wheel with the shoe applied and 210 revolutions with the shoe raised. At all other speeds the cycle was 100 revolutions of the wheel with the shoe applied and 610 with the shoe raised. Since twenty cycles comprised a test, the shoe was in contact with the wheel for approximately 6.25 miles. A test was run at each pressure and speed up to the capacity of the driving engine.

From the table it is evident that the highest values of the coefficient of friction occur at low speeds, and vice versa. At a given brake-shoe pressure the coefficient decreases rapidly as the speed is increased from 10 to 30 miles per hour; the decrease in the coefficient is small or zero with further increase in speed. With the speed constant there also appears to be a decrease in the coefficient as the brake-shoe pressure is increased. The brake-shoe wear on the chilled iron wheel, at shoe pressures of 2,000 to 3,000 pounds, becomes greater as the speed is increased up to 40 miles per hour; between 40 and 50 miles per hour the shoe wear is practically constant. With the speed constant the shoe wear is greater as the shoe pressure is increased.

Coefficient of Friction Using Diamond "S" Brakeshoes

Nominal Brake-shoe Pressure Pounds	Nominal Speed M. P. H.	Coefficient of Friction Chilled Iron Wheel	Forged Steel Wheel
1,000	10	39	
	20	31	
	30	27	
	40	23	
	50	24	
1,500	10	36	
	20	27	
	30	21	
	40	22	
2,000	10	35	29
	20	27	21
	30	20	20
	40	20	19
	50	20	20
2,300	40	18	
2.350	50	17	
2,450	30	19	
2,500	20	17	
	30	17	
3,000	10	35	
	20	27	
	30	20	
	40	18	
	50	17	
5,800	15	12	

As to the comparative coefficient of friction for the brake-shoe on chilled and steel wheels, it was found that in only three tests (with 1,000-, 2,000-, 2,500-lb. shoe pressure at 5 miles per hour) of the entire series did the mean coefficient of friction for the steel wheel exceed that of the chilled iron wheel. For these three cases the values were so nearly alike that for practical purposes they may be considered equal. In each of the remaining tests the coefficient found for the chilled wheel was greater than that for the steel wheel. In thirty-five tests (excluding the three previously mentioned at 5 miles per hour) the friction between the brake-shoe and the chilled iron wheel averaged 21 per cent higher than the friction between the same shoe and the steel wheel. In other words, chilled iron wheels, under the test conditions as to kind of shoe and within the speed and pressure ranges occuring, are apparently more effective in retarding cars or destroying energy than steel wheels. The inference might be drawn that due to its greater retarding properties the shoe wear on the chilled iron wheel would be greater than that on the steel wheel. Although individual tests may be selected in which the shoe loss on the steel wheel is considerably less than that on the chilled iron wheel, the whole series of tests shows that for 3,800 million foot-pounds of work done on each wheel, the loss with the steel wheel amounted to 14.98 pounds, whereas that with the chilled iron wheel was 11.18 pounds.

Thermal Expansion of Car Wheel Irons

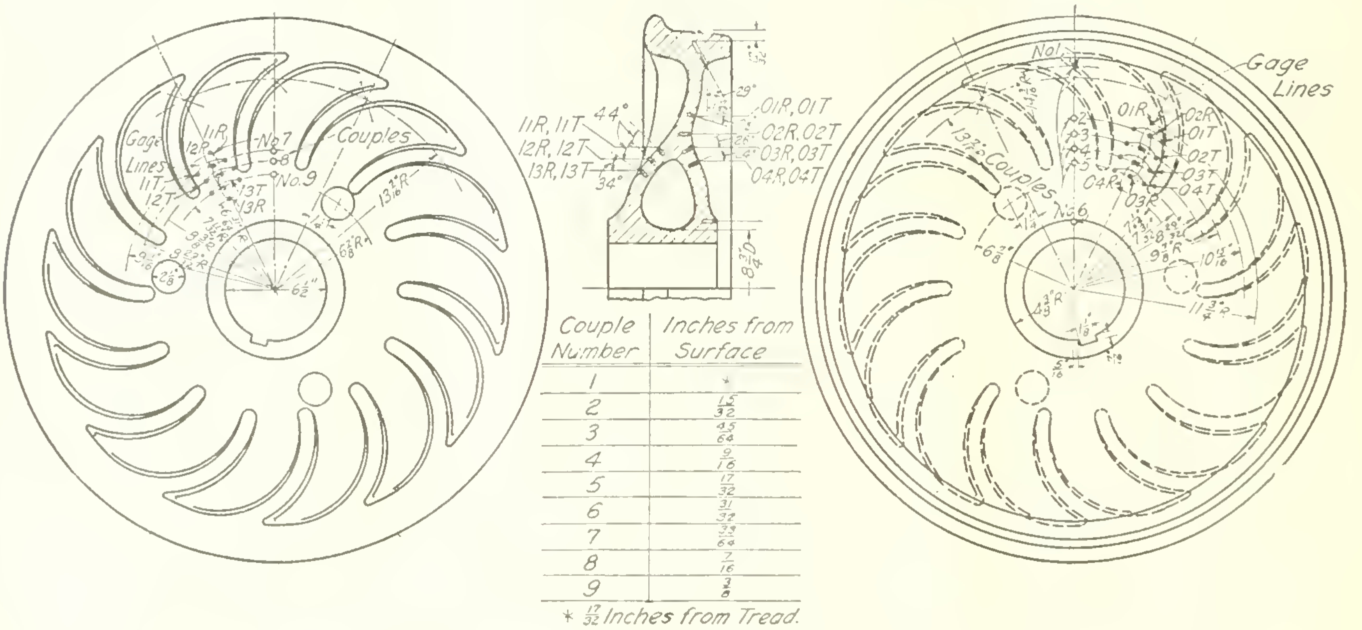
A bar of metal having a coefficient of expansion other than zero, if subjected to a change in temperature and if free to move, will undergo a change in length. However, if the bar is fixed so that the change in length does not occur freely, it is evident on both the temperature change and the fixity of its ends. A strip of metal fixed within and part of a larger body of the same metal may be subjected to tensile or compressive stresses from the surrounding material at the same time that it undergoes a change of temperature. It is in this way that the material of a car wheel, having within it unequal temperatures, is subjected to deformations which are in part due to temperature change and in part to the stresses which are set up by the unequal temperatures. If the total deformation or strain along a certain line within a car wheel is determined, and also the expansion of the material when unrestricted and subjected to temperature change, then the difference between the two determinations would constitute the strain and would be a measure of the stress existing. The more important stresses produced in a car wheel through temperature gradients, as when brake application causes a high temperature at the tread with a comparatively low temperature at the hub, are those of tension. These stresses produce elongation of the metal within the wheel, particularly along radial lines. The rate of thermal expansion or coefficient of expansion for several different grades of cast iron used in car wheels and for several specimens of steel was found in order to make use of the method of determining strain which is here outlined.

Results of Thermal Expansion Tests

The expansion of five specimens cut from chilled iron car wheels, two specimens of ordinary cast iron, one specimen of mild steel, and one of tool steel, was ascertained. The average coefficient of lineal expansion of five different specimens cut from three different wheels was .0000071 per degree Fahr. This was assumed to be representative of the expansion of chilled car wheel irons by heat in all the calculations involving the factor of thermal expansion; and all the strains reported in connection with the brake application tests on chilled iron wheels are made dependent on the assumption of this coefficient.

Preparation and Method of Testing Wheels for Effect of Brake Application

In the preparation of wheels for these tests various arrangements of the gage-lines and thermocouples were adopted in an effort to locate the positions of maximum strain or stress. After several wheels had been tested, it was noticed that the strains on the inner face were relatively small, and thereafter all measurements were confined to the outer face. The first wheel test was prepared with six thermocouples and with four radial and four tangential gage-lines. On wheels tested later the number of observation points was increased to include nine thermocouples and seven radial and seven tangential gage-lines. In Fig. 1 there is shown the location of the thermocouples and gage-lines on the 625-lb. wheel. This particular wheel had one thermocouple, numbered 1, in the tread or chilled part of the wheel, 17/32 inches from the surface and located laterally so as to be approximately under the center line of the brake-shoe. Service failures of wheels by long-continued brake application have indicated that the weaker part of the wheel is near the junction of the outer and inner faces. Accordingly, four couples, Nos. 2 to 5 inclusive, were placed in this region on the outer face of this wheel and one additional couple, No. 6, as close to the axle or shaft as possible. On the inner face three couples (numbered 7, 8, and 9) were located. The holes for the couples were drilled 7/32 inches in diameter and of such a depth that the junction of the two wires was halfway through the metal at the point in question. For several reasons it was impossible or impracticable to place the gage-lines on the same radial line as that on which the thermocouples were located. In order that the middle point of the gage-lines would have the same relative location with respect to the bracket as the thermocouples, the gage-lines were placed on a radial line, whose angular distance from the radial on which the couples were located was 360 divided by the number of brackets, or in this case 25.70. All strain-gage-holes were made with a No. 54 (0.055 in.) drill and 2 inches apart in both radial and tangential directions. The gage-lines so established were designated by three characters; the first was either the letter "*O*" or "*I*," signifying outer or inner face, respectively; the second was a numeral designating its position relative to the tread of the wheel; and the third was either the letter "*R*" or "*T*," denoting, respectively, a radial or tangential direction of the gage-line. Thus, O3R signifies the gage-line on the outer face, third from the tread, and in a radial direction. Likewise, O3T indicates the gage-line similarly located on the wheel, but in a tangential direction. Four radial and four tangential gage lines were placed on the outer face of this wheel at distances from the centre corresponding to those of couples Nos. 2-5, inclusive. On the inner face the distance from the centre of the wheel to the three radial and three tangential gage-lines corresponding to those of couples 7, 8, and 9. The location of the thermocouples and gage-lines are given in the illustration



Couple Number	Inches from Surface
1	*
2	15/32
3	45/64
4	9/16
5	17/32
6	31/32
7	33/64
8	7/16
9	3/8

* 17/32 Inches from Tread.

Fig. 1—Location of Gauge Lines and Thermocouples, 33 inch, 625 lb. Wheel

A typical set of curves embodying the principal results of a single test is shown in the illustration. In these curves are given the temperatures at four positions in the wheel, taken throughout the time of the brake application and the subsequent cooling of the wheel.

In this test the nominal brake-shoe pressure was 2,000 pounds, the speed of rotation of the wheel equivalent to a forward speed of 10 miles per hour, and the length of the test 120 minutes, corresponding to a distance of 20 miles. In applying the shoe for this distance, the work performed by the shoe on the wheel was 75.5 million foot-pounds.

The work curve for this test would be practically a straight line the slight deviation therefrom being due to variations in the friction between brake-shoe and wheel In performing work on the wheel the brake-shoe was worn at the rate of 0.252 pounds per 100 million foot-pounds of energy destroyed. On the basis of 75.5 million foot-pounds of energy absorbed in a run of 20 miles we have 3,775,000 per mile so that the wear per brake-shoe per mile would be about .0095 lbs. per mile.

The coefficient of friction in this test ranged from 0.30 to 0.40, the average of the instantaneous values being 0.35. The variation may be explained by differences in the structure of the shoe in contact with the wheel, and slight fluctuations in the speed. Attention is specifically

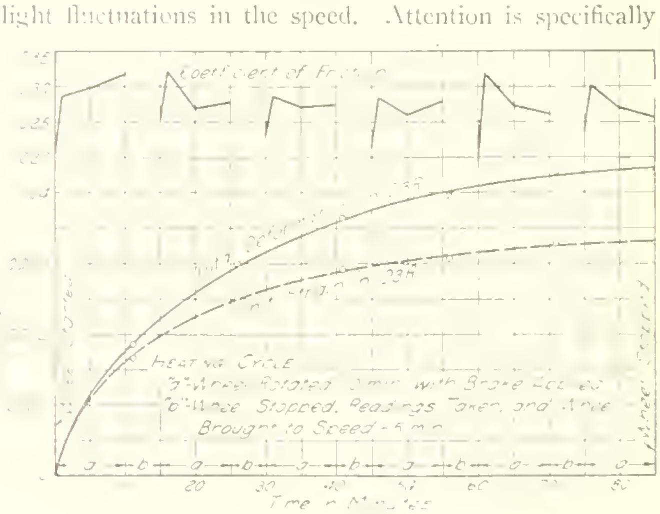


Fig. 2—Strains Developed in 33 in., 625 lb. Wheels

directed to the fact that the value of the coefficient at the end of two hours' brake application is practically the same as at the beginning of the test. This indicates that the coefficient of friction did not increase with length of brake application or with increased distance through which the brakes were applied. The ordinary variations in the char-

SUMMARY OF PRINCIPAL RESULTS OF CONTINUOUS BRAKE-APPLICATION TESTS

33-in. 650-lb. Arch Plate Wheel No. 633,452

Test No.	Brake-shoe Pressure lb.	Speed mi. per hr.	Distance mi.	Coefficient of Friction, Mean	Temperature Difference Between Couples Nos. 1 and 6 Deg. F.	Unit Deformations at Stopping in. per in. Maximum Tensile Strain	At Gage-line
			Wheel Slightly Eccentric				
2285 A	2,019	9.98	19.95	0.34	332	0.0021	04R
B	2,023	19.96	19.96	0.26	469	0.0027	04R
C	2,022	30.06	15.03	0.20	284	0.0021	04R
			Wheel Ground True				
2285 A1	2,019	9.98	19.96	0.39	375	0.0022	04R
B1	2,015	19.93	19.93	0.27	437	0.0027	04R
C1	2,016	29.84	14.92	0.23	595	0.0034	04R
D	2,014	39.88	9.97	0.21	375	0.0023	04R
E	2,015	49.75	9.95	0.21	474	0.0023	04R

SUMMARY OF PRINCIPAL RESULTS OF BRAKE-APPLICATION TESTS

33-in. 725-lb. M. C. B., 750-lb. M. C. B., and 750 lb. Arch Plate Wheels

Test No.	Brake-shoe Pressure lb.	Speed mi. per hr.	Distance mi.	Coefficient of Friction, Mean	Temperature Difference Between Couples Nos. 1 and 6 Deg. F.	Maximum Tensile Strain	At Gage-line
	33-in. 725-lb. M. C. B. Wheel No. 157,999. (Actual weight 718 lb.)						
2288 A	2,005	10.01	20.02	0.35	340	0.0031	05R
B	2,003	19.95	19.95	0.26	427	0.0039	05R
C	2,002	30.00	15.00	0.21	435	0.0034	05R
D	1,999	39.92	9.98	0.21	327	0.0029	05R
E	2,002	49.75	9.95	0.19	444	0.0029	05R
	33-in. 750-lb. M. C. B. Wheel No. 157,998. (Actual weight 724 lb.)						
2287 A	2,012	10.02	20.04	0.34	351	0.0020	05R
B	2,006	19.98	19.98	0.26	395	0.0027	05R
C	2,006	30.00	15.00	0.24	455	0.0027	04R
D	2,005	39.92	9.98	0.20	443	0.0023	04R
E	1,998	49.84	9.97	0.21	340	0.0025	04R
	33-in. 750-lb. Arch Plate Wheel No. 633,445. (Actual weight 744 lb.)						
2286 A	2,022	10.01	20.02	0.32	317	0.0021	06R
B	2,011	19.99	19.99	0.23	382	0.0027	06R
C	2,003	29.82	14.91	0.18	461	0.0021	06R
D	1,999	39.96	9.99	0.17	352	0.0022	06R
E	2,011	50.00	10.00	0.17	417	0.0023	06R
C1	2,016	29.54	14.77	0.16	515	0.0028	06R
F	2,442	30.04	15.02	0.19	540	0.0029	06R
G	2,300	39.76	9.94	0.18	462	0.0030	06R
H	2,352	48.50	9.70	0.17	603	0.0028	06R / 05R
H1	2,359	49.30	9.86	0.17	360	0.0030	06R
H2	2,358	49.75	9.95	0.16	542	0.0025	05R
	33-in. 950 lb. Arch Plate Wheel No. 103,219						
	5,830	15.35	3.71	0.12	...	.....	...
2262	1,001	10.00	19.99	0.39	138	0.0007	02R
2262 A	1,004	10.03	10.03	0.39	152	0.0010	03R
2263	983	19.98	19.98	0.27	242	0.0006	03R
2263 A	1,009	20.18	10.09	0.33	...	.....	03R
2263 B	1,004	20.09	30.14	0.31	350	0.0003	04R
2263 D	1,015	20.22	10.11	0.35	200	0.0008	03R
2264	1,012	30.33	20.22	0.36	265	0.0014	02R
2264 A	1,002	30.09	10.03	0.29	215	0.0010	03R
2265	1,011	40.16	20.08	0.23	321	0.0011	02R
2266*	1,006	49.18	19.67	0.26	298	0.0016	03R
2266 A	1,006	49.20	19.68	0.25	338	0.0015	03R
2266 B	1,004	49.25	9.85	0.21	255	0.0013	03R
2255	1,520	10.02	16.70	0.28	...	.....	..
2259	1,515	10.04	20.08	0.38	...	.....	..
2258	1,514	19.95	19.95	0.25	...	.....	..
2260	1,506	30.22	20.15	0.21	...	.....	..
2261	1,503	40.96	20.48	0.22	...	.....	..
2268	2,025	9.98	19.97	0.36	267	0.0014	02R
2268 A	2,018	9.98	9.98	0.35	250	0.0020	03R
2269	2,022	19.99	19.99	0.28	344	0.0021	03R
2269 A	2,016	20.06	10.03	0.29	318	0.0018	03R
2269 B	2,017	20.07	30.11	0.29	350	0.0023	03R
2267	2,023	30.21	20.14	0.20	385	0.0018	03R
2267 A	2,013	30.30	10.10	0.24	373	0.0016	03R
2270	2,018	40.28	20.14	0.21	457	0.0026	02R
2271	2,018	49.75	19.90	0.18	462	0.0025	03R
2271 A	2,020	47.65	9.53	0.23	380	0.0021	03R
2256	2,507	19.92	19.92	0.18	...	.....	..
2256 A	2,512	20.02	20.02	0.16	...	.....	..
2256 B*	2,502	20.05	26.73	0.19	...	.....	..
2256 C	2,509	19.78	19.78	0.17	...	.....	..
2257	2,502	30.45	17.76	0.18	...	.....	..
2257 A	2,505	30.19	30.19	0.17	...	.....	..
2272	3,009	10.04	20.08	0.36	373	0.0024	03R
2272 A	3,021	10.02	10.02	0.34	334	0.0020	03R
2273	3,003	30.02	20.02	0.27	448	0.0029	03R
2273 A	3,010	20.20	10.10	0.26	283	0.0020	03R
2274	3,005	30.16	20.11	0.20	555	0.0034	03R
2274 A	3,009	30.36	10.12	0.19	...	.....	03R
2275	3,012	40.20	20.10	0.18	540	0.0033	03R
2276	3,015	49.48	19.79	0.17	473	0.0037	03R

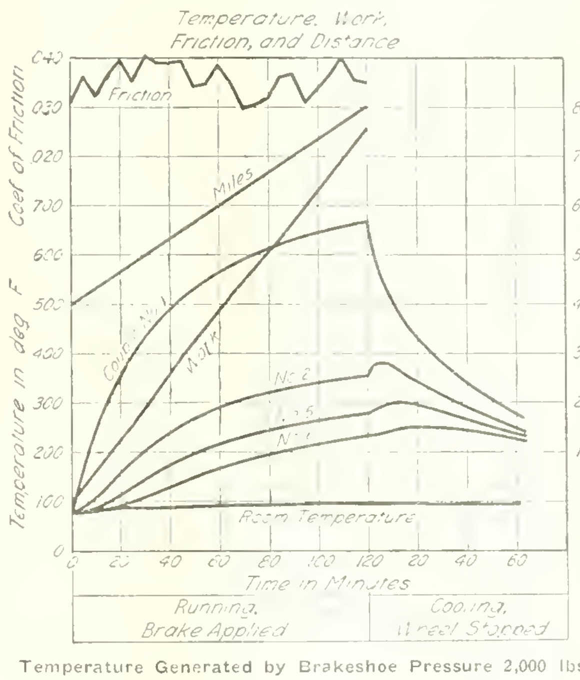
SUMMARY OF PRINCIPAL RESULTS OF BRAKE-APPLICATION TESTS

33-in. 786-lb. Forged Steel Wheel No. 6162

Test No.	Brake-shoe Pressure lb.	Speed mi. per hr.	Distance mi.	Coefficient of Friction, Mean	Temperature Difference Between Couples Nos. 1 and 6 Deg. F.	Maximum Tensile Strain	At Gage-line
2289 A	2,008	9.90	19.81	0.29	335	0.0036	03R
B	2,011	19.83	19.83	0.21	411	0.0044	03R
C	2,009	29.78	14.89	0.20	410	0.0042	03R
D	2,003	39.64	9.91	0.19	393	0.0035	03R
E	1,999	49.75	9.95	0.20	391	0.0040	03R

acter of the shoe metal in contact with the wheel appeared to be as likely to cause an increase as a decrease in the value of the coefficient during the progress of the test. Hence, in the solution of either design or retardation problems the question of variation in the coefficient of friction with time should be considered from the standpoint of differences which may exist in the character of the shoe metal exposed to the wheel.

It was noticed early in the tests that some parts of the tread, as indicated by their color, became much hotter than others. While the larger portion of the rim was bluish in color there were spots about the size of a silver dollar that were cherry red, or even a brighter red. The location of these hot spots changed with time. At a certain instant a hot spot might occur in the region of the thermocouple, a few seconds later this spot would have



Temperature Generated by Brakeshoe Pressure 2,000 lbs., Speed 10 M. P. H. for 20 Miles

cooled off and another hot spot would develop at a considerable distance from the first. As these variations in temperature from point to point on the tread were reflected in the readings given by Couple No. 1, the irregularity of these readings is thus explained.

As the brake-shoe pressure and speed were increased, the hot spots became more pronounced. Larger differences were noted in some of the later tests between individual temperature readings given by Couple No. 1 and the average tread temperature, as shown by a smooth curve. As the metal surrounding the other couples was not subject to rapid temperature fluctuation, smooth curves may be drawn to represent the temperature variation with time at the points where these couples were located. After the wheel had been rotated for 120 minutes, Couple No. 1 indicated a tread temperature of 669° Fahr., while Couple No. 6 showed the hub temperature to be 233° Fahr.; there was therefore a difference of 436° Fahr. between these points.

With the wheel stopped, the tread temperature drops rapidly due to radiation and conduction of heat through the wheel. On account of the continued conduction of heat through the wheel, the temperatures at other points where the thermocouples are located, continue to rise for a short time after the wheel is stopped.

At the instant of stopping the total deformation was 0.0047, of which 0.0015 was caused by thermal expansion, leaving 0.0032 as the maximum unit tensile strain. The deformation curves indicate that with respect to the strains caused by temperature gradients, the unit tensile strains in the radial direction on the inner face of the wheel, and also those in the tangential direction on the outer face, are relatively insignificant when compared with the strains in radial gage-lines 02R, 03R, and 04R on the outer face.

The character of the deformation of the wheel while being tested is shown by the typical diagram of strains developed in 33 in. 625 lb. M. C. B. wheel through intermittent brake application.

It will be noticed that there are two curves one of total deformation and the other of the unit strain. The principle on which the calculation of the lower of these curves was based has already been explained.

In the report the calculation with the exception of the steel wheel, has been limited to the tensile strain set up by the differences in temperature between two gauging points. These strains are given in decimals of an inch, and as they constitute the gist of the investigation, and set forth a matter that is of the utmost importance they are given in full.

The Pennsylvania Railroad and the Automatic Coupler

A Chapter in the Development of the American Car

By GEORGE L. FOWLER

In the course of the evolution of the American car there have been many and perplexing details to be solved. Among them, and not the least was that of a suitable coupling. In the early seventies the universal method of coupling freight cars together was the link and pin. It was a lose, dangerous and unsatisfactory method, and before 1880 there was a strong agitation in and out of railroad circles for something better and something that should be so automatic in its action as to obviate the necessity of a man going between the cars to make a coupling. Very many devices were patented and presented to railroads, and one, the Miller coupler, buffer and platform was extensively used in passenger equipment. This construction never obtained a foothold on the Pennsylvania. It was not because cars could not be coupled and drawn by it but because it did not in the opinion of Theodore N. Ely, the superintendent of motive power, fulfill the requirements of a coupler.

In this connection a digression may be permitted to show Mr. Ely's method of approaching a subject and deciding upon the merits of any mechanical device. He was wont to lay down certain essential requirements that the device must meet in order to be satisfactory. These were his fundamentals and all others became adjuncts. So in his requirements for a coupler the first and foremost was that it must be possible to couple cars without shock. This the Miller could not do. It was associated with buffers that were held out by springs, so that, when the attempt was made to keep them in contact by pushing them out farther, it required quite a shock to bring the hooks together, as all will remember who have had experience in riding on or coupling trains with the Miller hook. Mr. Ely's idea of a buffer was one that should be designed so as to work in both directions. That is, if the train were stretched the buffers should come more firmly in contact, and the same if the train is being compressed. That is, the buffer should be forward no matter whether the train was being stretched or compressed.

The result of these requirements was that the Pennsylvania held aloof from the adoption of a device that seemed to lack the possibility of ever being developed so as to meet these fundamental requirements, and its passenger cars were fitted with the crude device of the link and pin when the Miller coupler was almost universally used on American railways.

It was in 1877, that Eli H. Janney brought the coupler, that has since been adopted as standard on all American rolling stock, to Altoona. Mr. Janney had been a major in the confederate army, and on the staff of General Lee. At the close of the war he returned to Alexandria to find his family in a condition of desperate poverty and he set out at once about their relief. He was a man with a very strong bent for mechanical design and workmanship, and later he developed the coupler to which he has given his name. He offered it first to J. D. Lang, general manager of the Western Lines of the Pennsylvania but nothing serious was done with it until he brought it to Altoona and offered it to Mr. Ely.

The design was so thoroughly mechanical, crude as it was, that Mr. Ely was at once attracted by its possibilities.

Janney's idea was that the hook of the coupler and the arm from the hook, which is locked for two teeth of a four toothed cog, and that two cogs of opposing couplers came together and meshed as any good, well-constructed cogs would do, and that all he had to do was to lock one of the teeth and provide a horn, so that they could not spring apart.

It was what the railway world was loking for; some construction that would relieve the shock of the collision of cars coming together and prevent telescoping. Given the coupler, it was necessary first to design a platform and then buffers that could be used in connection with it. Mr. Ely undertook this, and the original buffer that was used for years on the Pennsylvania cars with the Janney coupler was of his own design.

Passenger cars were first equipped with the new device; then it was put on freight cars, and this long before it was adopted by the Master Car Builders' Association or the Interstate Commerce Commission.

During the later eighties there was an insistant demand that the railways should adopt an automatic coupler for their freight cars. The railways were quite willing and anxious, to adopt such a device, as a standard, if one could be found that would meet the requirements of service. Although the patent office had been granting patents on such devices at the rate of from eight to nine a week for several years and they were offered for consideration by the hundreds, there was none that presented a possibility of satisfactory action except the Janney.

It was evidently impossible to adopt this as a standard so long as the patent was held by Mr. Janney. In short he seemed to hold the key to the situation.

Mr. Ely sent for him and told him that he was about to advise him to take a very big and momentous action and dedicate the right to use the contour lines of his coupler to the Master Car Builders' Association. Mr. Ely's argument was that no one man could hold back so big a thing as an automatic coupler for freight cars for which the whole country was clamoring. That the Janney coupler, as then designed, was a good one, but there were probably other means of accomplishing the same object and there was bound to be a coupler that every one could use. This coupler is a good one and everybody recognizes it as such. A factory is already built, and many are being made and sold. So that, even if it were to be thrown open, he (Janney) would have at least two years the start of any competitor and by the time that competitor gets fairly into the field the Janney coupler will have a fair start towards universal use. After other people began making couplers, he would have an equal if not a better chance than all the rest and the profit will come from manufacturing and not from the patent royalties.

Mr. Janney saw matters in the same light. The proposition was made and conversation held in Mr. Ely's office in the morning. In the afternoon Mr. Janney returned and announced his decision to accept the advice and throw his lines open to all. The result was that in 1887, the executive committee of the Master Car Builders' Association recommended the adoption of the Janney type of coupler as standard. The matter was submitted to letter ballot; it was adopted and has since come into universal use on all passenger and freight cars in the United States, and will probably continue to hold its own.

As Mr. Ely said to Mr. Janney the car coupler question was too big for any one man to hold and control, and it is not at all probable that if Mr. Ely had failed to act as he did, and advise Mr. Janney as he did, that this coupler would have gone into oblivion by default. But the fact is that he was the first to seriously recognize its merits, and did advise the patentee to surrender his rights to the public, and that the final outcome of these actions has been the universal adoption of a most important detail of the car.

American Railway Association

MECHANICAL DIVISION

The Result of Letter Ballot

At the Atlantic City meeting of the Mechanical Division of the American Railway Association, there were a number of recommendations made by the several committees relating to locomotives, cars and materials that have been submitted to letter ballot for adoption as standards or recommended practice. The returns of this letter ballot are now in and the circulars setting forth the results have been issued.

Seven subjects relating to locomotive matters were submitted, six of which were adopted and one rejected. The rejected subject was the proposition to use button head staybolts, as shown in the accompanying illustration, for crown-sheets in other than oil-fired boilers. The other six recommendations which were adopted were: Specifications for dry pipes; the use of hot water under pressure for washing out boilers; the standardization of the design and maintenance of turbo generators, and the bolt spacing for headlight cases.

In connection with the hot water filling and washout systems the committee earnestly urges upon the management of the railroads the importance of installing hot water washout and fill systems, thereby effecting economies and efficiency with little expenditure of capital.

In car matters there were eight committees reporting recommendations that covered fifty-four propositions, all of which were adopted.

The recommendations of the committee on car construction included rules for the construction and maintenance of ice tanks and other attachments for refrigerator cars; the adoption of standard centre sill sections; a modification of the standard lamp signal socket and the adoption of a standard marker bracket; then there were three propositions for designating letters for cars; the adoption of standard gauges for centre plates; one to increase the thickness of the bottom arch bar for cars of 80,000 lb. capacity and the adoption of end stake pockets for flat cars. All of these were adopted.

The committee on couplers and draft gears modified certain paragraphs of specifications and the limiting weights for the type "D" couplers, and proposed standard gauges for the bottom lock lift lever, bottom lock lift toggle and bottom lift lever gauge pin, all of which were adopted.

All of the recommendations of the committee on brakeshoe and brake beam equipment were adopted, and these were a modification of the reinforced back brakeshoe; also of the brakeshoe key design, and a change in the standard specifications for the brakebeams.

The committee on train brake and signal equipment were supported in their recommendation for the advancement of the two pressure spring type of retaining valve from recommended practice to standard.

The committee on car wheels made a change clarifying the rule as to the condemning limits for steel and steel-tired wheels on account of wear; a change was also made in the drawings for maximum and minimum flange thickness gauges for cast iron, wrought steel and steel tired wheels, and the recommended practice was changed in the matter of the rule for mounting wheels with respect to hardness mating. An important factor in increasing the life of wheels is to pair and mount on the same axle wheels of as nearly as possible similar physical characteristics. The committee considered the question of attempting to mate wheels of equal hardness, but it is their conclusion that the only practical method of doing this is in the case of solid wrought carbon steel wheels to mate them within a .05 per cent carbon content range, and in the case of cast iron wheels to mate by tape sizes as already provided for. It is therefore recommended that the following section be added to the paragraph on mounting wheels:

> "In the case of new wrought steel wheels, those mounted on the same axle should not differ in the carbon content by more than .05 per cent."

There were three propositions of the committee on train lighting and equipment, all of which were adopted. They related to the specifications for lamp regulation, and a schedule of train lighting.

Twenty-three propositions were made by the committee on loading rules, all of which were adopted. They all related to modifications of the rules as they now exist.

The committee on tank cars submitted nine propositions, all of which were accepted. They related to the application and tests of safety valves; bottom outlet valves, of which there were three; a method of automatically venting the pressure in the tank when a start is made to remove the dome cover; the requirements for heating systems in new tank cars and installation in existing cars; the addition of certain requirements to be observed when cars are rebuilt or extensive alterations made whereby better workmanship will be insured, and a specification for the testing of these cars as follows:

All tests shall be made by completely filling the tank with water of a temperature which shall not exceed 70 degrees F. during the test, care being taken not to spill any water on the tank and that all fittings are tight. The pressure may be applied in any suitable manner. The tank shall hold the prescribed pressure for not less than twenty minutes without leak or evidence of distress, with the source of pressure disconnected. While the tank is under test pressure it shall be carefully inspected for evidence of leakage. If the jacket and insulation are not removed, a drop in pressure shall be evidence of leakage, and such portion of the jacket and insulation shall be removed as may be necessary to locate the leak and make repairs. After the repairs have been made the tank shall again be subjected to the prescribed test.

In this connection attention is called to the desirability of using some form of talc wash or graphite paint on the outside of the tank and inside of the sheet iron jacket in order to prevent the insulting material from sticking fast and being damaged so that it can not be re-used when it is necessary to remove it for any purpose.

The recommendations of the committee on specifications and tests for materials were divided into ten propositions, all of which were adopted. They were as follows: A revision of one section of the standard specification for signal hose; the same for the specifications for turpentine, oxide of iron paste, black semi-paste paint, raw linseed oil, boiled linseed oil, red lead, mineral spirits, red lead and oil and for extended red lead paste.

Locomotive Air Pump Air Valve Lift Gauge

This gauge is so designed that the lift of all of the air valves of the 9½ in. air pump can be measured and adjusted to meet the requirements.

It is in the form of a T-square and of the dimensions given in the details. The head is 3/16 in. thick and is cut away with a groove on one side, one edge of which has a dove-tail. The blade has both edges beveled so that it fits into the bevel in the head on one side and is held by the undercut dove-tail groove of the piece X on the other. This piece X is held in place by the thumb screw as shown. With this arrangement the head is reversible on the blade or can be moved from one end to the other as may be desired.

The notches on the sides of the blade which are 3/32 in. and 5/32 in. deep, indicate the standard and maximum lifts respectively. Two of these gauges are required for a set and the differences between them are indicated by the dimensions for which letters are given. These are, for detail No. 1.

A=4 in.; B=3¼ in.; C=3/8 in.

For detail No. 2, they are:

A=3in.; B=2½ in.; C=¼ in.

The method of using the gauge is shown by the several sketches at the left of the engraving.

In Fig. 1, the head on the gauge is set so that the notch on the end of the blade has a bearing on the rim of the valve cap and the projection on the head is against the center of the same. Then the gauge is turned over and projections on the head are set on the rim of the pump casting. When this is done and the teat on the blade just touches the top of the valve, the valve will have the maximum lift if the first setting was for the maximum side. If, when the teat is on the valve, the projections on the head do not touch the rim of the casting the lift will be less than the allowable maximum. In that case the gauge should be reset on the cap, using the notch for the standard lift on the blade. Then when the gauge is turned over the projections on the head should rest on the rim of the casting and if the teat on the blade just touches the top of the valve, the lift of the valve will be the standard of 3/32 in. If it does not touch, the lift will lie somewhere between the standard and the maximum of 5/32 in.

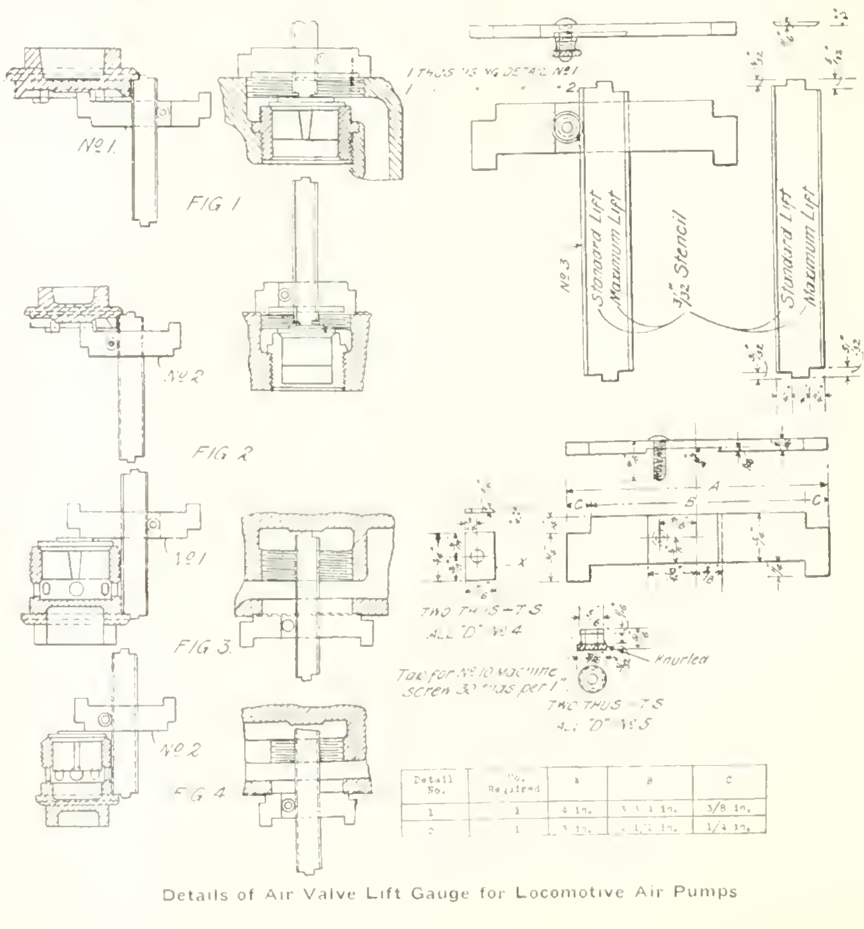
Fig. 3a shows similar applications of the No. 2 gauge.

Fig. 4b shows the application of the No. 1 gauge to the cage holding the bottom valve of the pump.

In this case the gauge is set so that the body of the head rests against the top of the valve at its center, and the notch on the tongue is against the rim of the cage where it screws against the body of the pump casting. It is then reversed and, if it has been set on the notch for maximum lift, the teat should touch the top of the casting before the head touches the rim. This would indicate less than the maximum lift. If they touch at the same time, it indicates less than the maximum. Then, by changing the first setting to the notch indicating the standard lift, the head should touch the rim before the teat touches the cap. When this occurs the lift will be between the standard and maximum. If the two surfaces touch at the same time; the lift will be the standard.

Fig. 4 shows a similar application of the No. 2 gauge.

With this gauge the lift of the air valves can be limited to as narrow a margin as may be desired, and an accurate determination made as to what the lift may be.



Details of Air Valve Lift Gauge for Locomotive Air Pumps

8,242 Cars Put in Service in Two Weeks

A total of 8,242 new freight cars of various classes and 208 new locomotives were installed in service during the semi-monthly period from March 15 to April 1, according to reports just filed with the American Railway Association. This brings the total number of new freight cars installed since January 1 up to 39,172. New locomotives placed in service during the same period total 935.

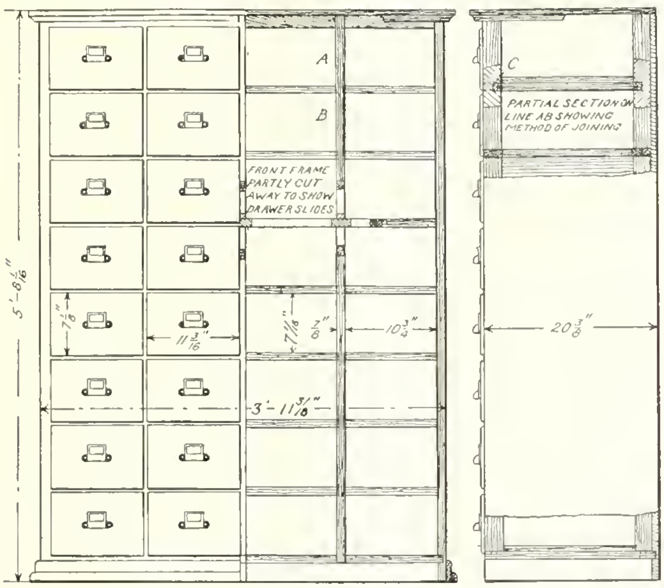
Shop Kinks

Handy Appliances in Use on the Erie Railroad

A File for Piecework Cards

Whether piecework ever comes back into its own or not, this file for piecework cards that was designed and built at the Meadville shops of the Erie Railroad will be of interest, because it can be used for the filing of any cards.

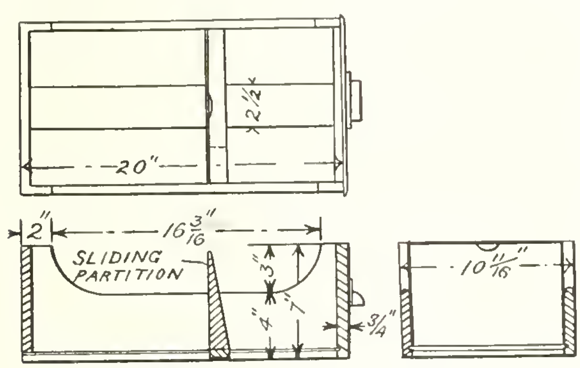
The file or case, as here shown, contains 32 drawers and measures 3 ft. 11⅜ in. wide and 5 ft. 8 1/16 in. in height.



Piecework: Card File Used on Erie Railroad

The drawers openings are 10¾ in. wide and 7 1/16 in. high, with a depth of 19¾ in. The sides and separating partitions are ⅞ in. thick, and the back ⅝ in. The vertical section on the line *AB* shows the method of framing.

The vertical partition pieces are ⅞ in. thick and 2 in. deep. At each drawer support they are cut away, as at *C*, in the form of a gain in which the horizontal strips are set. These are grooved, as shown, so as to take the



Drawer for Piecework Card File

tongue of the T-shaped drawer supports, a construction that is used both at the front and back. This is clearly shown in the engraving.

The drawer has a total length of 20 in., a width of 10 11/16 in. and a height of 7 in., which gives it a clearance of 1/16 in. at the top and 1/32 in. at each side, so that there is no danger of its sticking because of binding at the sides. It is made of material ⅝ in. thick, except the front, which is ¾ in. thick, thus adding a stiffness at the point of pull.

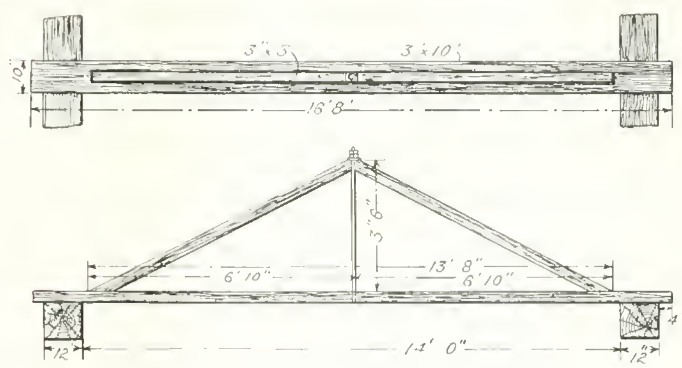
The bottom has a slot 2½ in. wide running its whole length and the underside is cut away to receive the lower portion of the sliding partition by which the cards are kept bunched.

The titles of the cards that were used in this were for work done in the blacksmith shop, boiler shop, and carpenter shop, on the boring mills, including the vertical horizontal and car wheel and drill presses, in the erecting shop, fitting department and grinding room, by the keyway cutters and millers, lathes, laboring gang, milling machines, planers, paint shop, slotters and wheel gang, and in the roundhouse, tank shop and tin, pipe and copper shop, twenty-five in all, leaving seven drawers for future requirements.

Bridge Tree and Stringer for Countershafts

It is frequently necessary to supplement the roof trusses or cross beams of the shop to support short lengths of countershafting. As they say in patent suits, the bridge tree here shown is one that any mechanic, skilled in the art, would be capable of designing and constructing, and is illustrated merely as a good suggestion.

It is shown as spanning a distance of 14 ft. between trusses. The horizontal member is 3 in. thick and 10 in. wide and is laid on top of the truss beams. This is a mere plank and would, of course, be quite too limber to carry



Bridge Tree and Stringer for Countershaft

any sort of a shafting hanger. The braces are of 3 in. by 3 in. material and have a footing gained ½ in. into the horizontal or tension member of the truss. The king pin is a ¾-in. rod, and the height of the truss is 3 ft. 6 in. Such a truss should be capable of supporting a static load of 4,000 lb. and be stiff enough to carry the lighter load of any ordinary countershafting with its attendant vibrations.

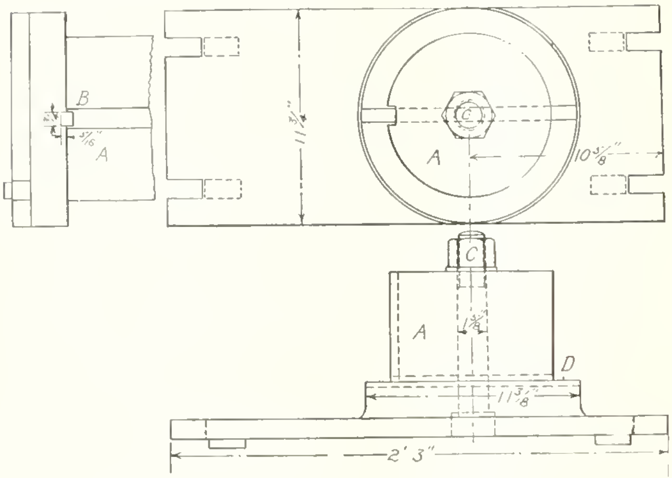
Chuck for Holding Eccentrics on Boring Mill

This chuck is intended for holding eccentrics on a boring mill while the outer surfaces are being turned. This requires that they be bored and the keyway cut before being placed on the chuck. As the eccentrics may be required for different diameters of axles, the block *A* of the chuck is made removable, and there is to be one turned and a keyway cut for each diameter of bore of eccentric that is to be used. This block is held in place by the key

B and the bolt *C*. As the bolt is made to fit tightly in the block it serves to center and hold it in place on the base.

The base is finished on the bottom and on the seat for the block *A* and is fitted with tongues and slots to suit the machine on which it is intended that it shall be used.

In setting up, the base is bolted to the table of the mill with the center of the bolt *C* out of center by the eccentrics that are to be turned. This done and the block *A* keyed and bolted in place, the work of setting the eccentric is rapid and accurate. It is simply necessary to slip it on over the block until it rests on the face *D*, put in the vertical key to prevent it from turning on the block, and it is ready for the work to be done upon it.



Chuck for Holding Eccentrics on Boring Mill

Air Pump Crane

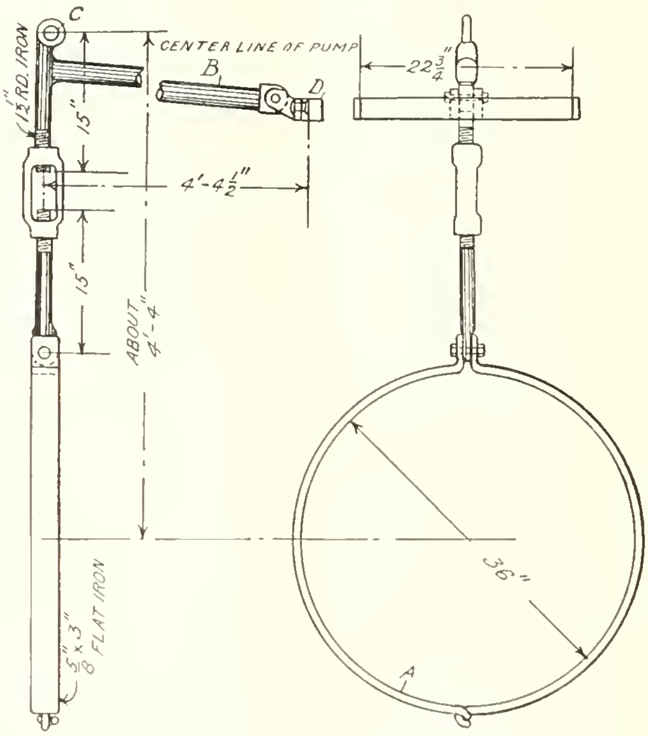
There have been a number of devices brought out for the handling of air pumps on and off of locomotives. The pump is a heavy piece of apparatus, rather awkward to handle because of its shape, and easily damaged if it is allowed to fall. The crane used for doing this work was designed and built at the Galion, Ohio, shops.

It consists of two legs each 14 ft. 10 in. long made of 3 in. by 4 in. pine with a cross bar of 3 in. by 6¾ in. oak. This cross bar has a block 3 ft. 3 in. long bolted to its lower side, which is cut away in an arc of a circle to fit the top of the boiler. At the end next the legs it has a strip of flat steel bolted to its upper side to serve as a track for a trolley wheel with a strap and hook on which a chain block can be hung for hoisting the pumps. The latter can be run clear of the locomotive and lowered to the floor. The device can be easily knocked down for stowing in a limited space.

Rigging for Removing Air Pumps from Locomotives

The crane just described requires that the top of the boiler in line with the air pump shall be clear to receive the saddle that is attached to and serves as a support for one end of the crosspiece on which the trolley travels. It so happens, however, that on a number of engines on the Erie Railroad, the top of the boiler is not clear at a point opposite the air pump, but the dome occupies that space. In order to handle the air pumps on and off of such locomotives, the device here illustrated is used.

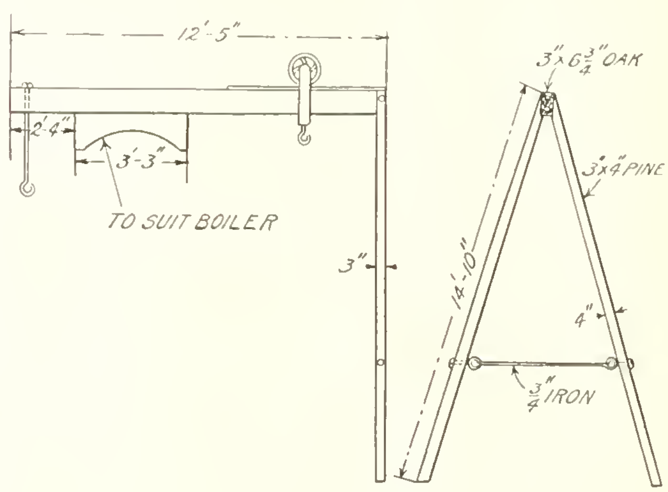
It consists of a strap *A* made to encircle the dome. This is made of ⅞ in. by 3 in. flat iron with a hook and eye at the ends so that it can be readily put in position. At the other side of the loop there is a 1 in. bolt that holds one end of an eye bolt, the threaded end being screwed into one end of a turnbuckle. There is a hammer-shaped piece, *B*, having a thread cut on one of the top ends to screw into the turnbuckle and with an eye in the other to take the hook of a chain or other hoist. This part of the device is held in a horizontal position by a strut of 2 in. round iron that stands at an inwardly projecting angle and may be made to rest upon any projecting part of the locomotive that is strong enough to carry the weight of the pump. Preferably it may be arranged to come to a bolt passing through a fixture similar to *D* which is fastened to the brackets to which the pump is bolted.



Rigging for Removing Air Pumps from Locomotives

Such a device can be put in position very quickly. The joints at the strap and at the fixture *D* make it possible to move the eye *C* in and out so as to adjust it to a point over the center line of the pump.

With the weight of the pump carried by the hoist and free from the engine, it can be swung away from its fastenings and be lowered to the floors.



Air Pump Crane

Snap Shots—By the Wanderer

We learned much in the war. Very much, more than we ever learned in so short a time before. But have we really learned what we learned? We have done a lot of things that we have never done before, and done them with amazing quickness. It was a case of woodchuck. The minister was coming to dinner and we had to have some meat. So we learned that if we wanted to get at the secrets of Nature in the way of poison gases, airplanes, efficient motors and depth bombs, we had to hunt for them. In short, intensive research was the cry, and we found that it paid. We found that the patient plodding of our enemy was a sort of worth-while quality after all.

But it's hard to teach an old dog new tricks, and the dog of American commercial life is a pretty old fellow and has been fed so long in his protected industry by the bountiful supply of food laying around loose, that he does not take kindly to a life in the woods where he must either tame or catch the squirrel before he can take to the tree. So it is more than likely that his ardor for research will cool considerably now that the pressure of necessity is removed. He will be more apt to nose around the domestic garbage can than take to the open in a hunt for fresh meat. Then when the garbage can is empty well — We have heard much of this cry for research, research, but has it really struck home? I ha' me doots. For example a few days ago I wrote more than forty letters to the manufacturers of a certain class of specialties, asking for information regarding the operation of that specialty under the everyday working conditions. What modifications they made for slight variations in conditions. Simple everyday questions that ought to have been put to their salesmen a thousand times a month. Did they answer them? Not one. They simply didn't know. "Caveat emptor!" "Let the buyer beware" had been and is their motto. If the goods are satisfactory, "Why should I worry?" Why indeed! Yet every mother's son of the whole bunch would have risen in admiration and applause at an investigation of almost any kind that gave results. It is just inertia and the reluctance to spend a dollar unless it has such a string tied to it that it is sure to come back dragging another with it. Yet they all believe in research — for the other fellow. As Louis Mann as the Tyrolese innkeeper remarked: "It is to laugh."

Sometimes the scoffer becomes a convert and then like all proselytes, "it is to laugh" to see how he jumps into the game. A certain well known man, so well known in fact that if I should name his name you would all sit up and take notice and many would say: "I knew him," a certain well known man, I say had been very successful in the exploitation of a number of railway specialties that he had devised and had gathered in a goodly number of ducats thereby. Then he launched into a really big thing. So big that he hoped to catch the world. He laid his plans and felt that he was right. He thought he could swing the United States but abroad he needed assistance. But somehow he ran up against a lot of Missouri skeptics both at home and in England. He could place a few samples on trial here at his own expense, but the English would have none of him and there were no sales at home Things looked black. His manager was a young man, who believed in the goods, yet realized that to sell he must have a Q. E. D. now and not wait ten years for a trial to end. So he engaged an engineer to look into it. It was a slow piece of work and the principal chafed and fumed and probably swore that all this tomfoolery was a waste of time and money. He wouldn't have it and the whole thing would have to stop. But the manager, who was a member of his family, said "Nay, nay, we go on." And go on they did.

It took nearly a year for the preliminary investigation to determine the relative merits of the new thing with the articles already on the market with which it was to compete. Then? Well, at the first crack out of the box, and the first presentation of the report, there resulted an order of about $50,000. The principal tucked the report under his arm and sailed for England. Two weeks sufficed to close a deal for the making of the specialty there. Then the convert came home, and the work was continued to the end. Result? Well, what could you expect? The thing became a great success, and the owner almost childish in his enthusiasm for research work.

But sometimes it doesn't work that way. Another specialty was on the market. Not altogether based on strictly scientific principles, but which looked good and had good talking points. It sold on its talking points and the talkers were making money. They, too, were sure of themselves, and they, too, wanted a Q. E. D. So an elaborate investigation was planned and carried out. But somehow the theories did not hold in the tests. The article failed, not badly, but its partial success was only an emphasis of what it really was. The report was unsatisfactory, the talkers half thought, though they did not give utterance to the thought that they had not had a square deal. The report was filed away among the sacred archives, and there it lies. May it rest in peace. But the talking went on, the sales went limpingly on, and the talkers have ceased to believe in the efficacy of research work as a means of trade exploitation.

Then there was that other crowd. They had a good thing and knew it, or thought they knew it. And they, also, proceeded to investigate. It took the better part of two years to do the work. And when it was done, oh, the joy that was in it. All the carping criticism was silenced. There could be no mistake, this was the real thing. And how they exploited the results. The coasts of the Atlantic and Pacific and all the intermediate terrain were flooded with the "Here's the thing to use." But— oh, but there was still a skeleton in the closet. A nasty skeleton of whose existence there had been many surmises and more questions. But if no one has ever really seen your skeleton you can lock the door and deny his existence, or if the inquirer be too insistant, you can gloss its existence over and say it isn't much of a skeleton anyway. So that is what was done. The suggestion of an investigation was frowned upon. To find out whether it was a really truly skeleton or merely a nightmare of one, was thought unwise. We don't know that we have a skeleton. It is only a suspicion. So long as we keep the door closed "neither you nor I nor nobody knows." But if we should unlock the door and it should really jump out at us, why some of our friends might be scared to death. "Where ignorance is security (with apologies to Gray) 'tis folly to be wise." So we'll walk bravely by the door, and if any chose to believe that it hides a skeleton, why let them. Who cares, they can't prove it. So there you are. You pays your money and you takes your choice.

Does research pay? Doesn't it pay to know just where you really stand? Do you post your ledger on your front door? Yet you keep your books for your own information, you maintain your family for the joy of life, you guard your own life because its about the best thing you have, much as you may have abused it. So possibly it may be well for you to know some unpalatable things that you may be guided to things that are better, and to get to that which is better, there is no better way than painstaking research.

Notes on Domestic Railroads

Locomotives

The Wabash has ordered 30 Mikado type locomotives and 20 switching type locomotives from the American Locomotive Company.

The Lehigh Valley has ordered 40 Mikado type locomotives from the American Locomotive Company.

Yngemo, Santa Fe, C. Por A. San Domingo has ordered 2 Consolidation type locomotives from the Baldwin Locomotive Works.

The Oregon American Lumber Company, Vermonia, Oregon, has ordered one Prairie type locomotive from the Baldwin Locomotive Works.

The Chicago Junction has ordered 6, 0-8-0 switching locomotives from the Lima Locomotive Works.

The Kansas City Southern has ordered 10, 2-8-8-2 Mallet type locomotives from the American Locomotive Company.

The Gulf, Mobile & Northern is inquiring for 5 locomotives.

The Simpson Logging Company, Shelton, Wash., has ordered one Mikado type locomotive, from the Baldwin Locomotive Works.

The Florida East Coast has ordered 15 Mountain type and 5 swtiching locomotivea from the American Locomotive Company.

The New York Central has ordered 8, 8-wheel switching locomotives from the Lima Locomotive Works.

The Bethlehem Steel Company is inquiring for 3, 0-8-0 type switching locomotives.

The Canadian Pacific has ordered 20 Mikado type locomotives from the Montreal Locomotive Works.

The Deer Island Logging Company, Oregon, has ordered one Prairie type locomotive from the Baldwin Locomotive Works.

The Louisiana & Arkansas is inquiring for two Mikado type locomotives.

The Fonda, Johnstown and Gloversville has ordered a switching locomotive from the American Locomotive Company.

The Missouri Pacific is inquiring for 40 Mikado and 10 Pacific type locomotives.

The Boyne City, Gaylord & Alpena is inquiring for two Mikado type locomotives.

The Minneapolis, Northfield & Southern is inquiring for two Mogul type locomotives.

The Paulista Railway of Brazil has ordered two Mountain type locomotives from the American Locomotive Company.

The Richmond, Fredericksburg & Potomac has ordered two eight wheel switchers from the American Locomotive Company.

Freight Cars

The Duluth Missabe & Northern has ordered 100 steel box cars of 50 tons capacity from the American Car & Foundry Company.

The Southern Pacific has ordered 350 steel ballast cars from the Mount Vernon Car Manufacturing Company.

The Chesapeake & Ohio has increased its order from 2,000 to 4,000, 70 ton hopper cars; 2,000 from the American Car & Foundry Company and 2,000 from the Standard Steel Cár Company.

The Atlantic Coast Line has ordered 450 gondola cars from the Virginia Bridge & Iron Company.

The Louisiana Railway & Navigation Company is inquiring for 150 box cars of 40 tons capacity.

The New York Central has ordered 2,000 refrigerator cars for Michigan Central from the Merchants Despatch Transportation Company.

The Bertha Coal Company has ordered 300 hopper cars of 55 tons capacity from the Pressed Steel Car Company.

The Atchison, Topeka & Santa Fe Contemplates buying about 2,000 refrigerator cars.

The Chicago, Indianapolis & Louisville is inquiring for 500 50-ton gondola cars.

The Johnstown Coal & Coke Company, Johnstown, Pa., has ordered 150 hopper cars, 55 tons capacity from the American Car & Foundry Company.

The Virginian Railway has ordered 1,000, 120 tons all steel gondola coal cars from the Pressed Steel Car Company and has also ordered 500 all steel 70-ton hopper cars from the Standard Steel Car Company.

The Norfolk & Western is reported as having placed an order for repairs to 700 hopper cars with the Ralston Steel Car Company.

The Spokane, Portland & Seattle is inquiring for 50 flat cars of 40 tons capacity.

The Louisiana & Arkansas has ordered 20 ballast cars from the American Car & Foundry Company.

The United States Fuel Company has ordered 500 hopper cars ot 70 tons capacity from the General American Car Company.

The Florida East Coal is inquiring for 200 flat cars and 200 ventilator box cars also for 10 caboose cars.

The Ford Motor Company has ordered 25 steel gondola cars of 70 tons capacity from the Standard Steel Car Company.

The Ann Arbor is inquiring for 500 automobile cars of 40 tons capacity.

The Norfolk & Western contemplates coming into the market soon for some freight cars.

The Sinclair Refining Company, Chicago, is inquiring for 5 tank cars of 6,000 gal. capacity, also for 10 tank cars of 8,000 gal. capacity.

The Elgin, Joliet & Eastern has ordered 80 underframe reinforcement from the Illinois Car & Equipment Company.

The Hocking Valley is inquiring for 1,000 steel frame automobile box cars of 40 tons capacity.

The Union Pacific is inquiring for material to build fifty steel underframe eight-wheel caboose cars which will be constructed at the Albina, Ore., shops of the company.

Passenger Cars

The Louisville & Nashville has ordered 10 coaches from the American Car & Foundry Company.

The Atlantic Coast Line has ordered 5 dining cars from the Pullman Company.

The Seaboard Air Line has ordered 4 combination baggage and mail cars from the Pressed Steel Car Company.

The Atchison, Topeka & Santa Fe is inquiring for 25 baggage cars, and 50 express refrigerator cars of 40 tons capacity.

The New York Central has ordered 6 all steel baggage cars, 60 ft. 6 inches, from the American Car & Foundry Company.

The Arms Yager Railway Car Company has ordered 50 passenger cars from the Pullman Company.

The Delaware, Lackawanna & Western has ordered 10 milk cars from the Standard Car Company.

The Illinois Central has ordered 25 60 ft. 6 inches steel suburban coaches from the Pullman Company.

The National Railways of Mexico have ordered 5 narrow gage passenger coaches from the Pullman Company.

The Missouri Pacific is having repairs made to 100 passenger cars, 50 by the St. Louis Car Company, and 50 by the American Car & Foundry Company.

The Atchison, Topeka & Santa Fe is having 3 business cars built by the Pullman Company.

The Akron, Canton & Youngstown is inquiring for two passenger mail and baggage cars.

The Atlantic Coast Line has ordered 52, 74 ft. steel coaches, 15, 70 ft. steel baggage cars and 5, 70 ft. combination mail and baggage cars from the Standard Steel Car Company.

Building and Structures

Atchison, Topeka & Santa Fe has plans under way for new locomotive and car repair shop at Kansas City, Kansas, to cost approximately $250,000.

Chicago & Northwestern has planned construction of a 10-stall round house and some additions to the shops at Casper, Wyo., which will cost $80,000.

Chicago, North Shore & Milwaukee will construct new car shops at Waukegan, Ill., to cost approximately $1,000,000. The shop at Highwood, Ill., will be discontinued.

St. Louis, San Francisco will construct a 15-stall round house and additional shop building at Monett, Mo., to cost approximately $500,000.

Southern Pacific plans the construction of a new round house at Lafayette, La.

Missouri Pacific plans the construction of a machine shop, 120 ft. by 60 ft. at Wichita, Kans., to cost $78,000.

Elgin, Joliet & Eastern has awarded a contract to the Leake Construction Company, Chicago, for the construction of a 20-stall round house at Gary, Ind.

Pere Marquette has awarded a contract to the Arnold Company, Chicago, for the construction of a round house at Grand Rapids, Mich.

Great Northern will construct a new round house, machine shop, and power plant at St. Cloud, Minn., at approximately $500,000.

The Ann Arbor will construct a new round house and machine shop at Owosso, Mich.

The Chicago, Rock Island and Pacific is asking for bids for the rebuilding of the round house at Shawnee, Okla.

The Missouri Pacific plans the construction of a new eight stall engine house at Osawatomie, Kans., at an estimated cost of $52,000.

Supply Trade News

W. J. Roehl, manufacturers representative with offices in the Railway Exchange Building, St. Louis, Mo., has been appointed to represent the **Locomotive Lubricator Company** in the Southwest territory.

Charles B. Yardley, who formerly represented **Jenkins Bros.**, New York has rejoined the staff of this organization and will again become their railroad representative for the same district.

Westinghouse headquarters in New York. Work has been started on a 23-story bank and office building at Broadway and Liberty street, New York, which will be known as the Westinghouse building. All the space above the eleventh floor will be occupied by the **Westinghouse Electric & Manufacturing Company**, together with the **Westinghouse Electric International Company**, the **Westinghouse Lamp Company**, the **Westinghouse Air Brake Company**, and other allied organizations.

W. C. Thatcher, assistant superintendent of construction of the **National Boiler Washing Company**, Chicago, has been promoted to general superintendent of construction, succeeding **J. M. Weir**, who has resigned.

W. O. Ashe has been appointed mechanical engineer of the **Commonwealth Steel Company**, St. Louis, Mo. He was formerly assistant engineer in the engineering equipment department of the New York Central Lines, with headquarters at New York.

The Westinghouse Electric & Manufacturing Company has announced the following changes in personnel: **Graeme Ross** has been appointed manager of the Kansas City branch office to succeed **F. F. Rossman**, who resigned to accept the position of vice-president of the Mobile Light and Railway Co., Mobile, Ala.

E. L. Doty, district service manager of the Buffalo branch office has been appointed Engineering Assistant, Service Department, with headquarters at East Pittsburgh.

J. A. Atkinson has been appointed Buffalo Service Manager.

C. W. Jones has been appointed General Foreman of the Controller Department at the East Pittsburgh Works of the Electric Company.

C. A. Fike has been appointed General Foreman of the Coils and Insulation Department at the East Pittsburgh Works of the Electric Company.

J. H. Hartman has been appointed General Foreman of the Storekeeping Department at the East Pittsburgh Works of the Electric Company.

W. S. Oswald has been appointed General Foreman of the Railway Motor Department at the East Pittsburgh Works of the Electric Company.

J. H. Klinck has been appointed Assistant Supervisor of Production of the Westinghouse Electric & Manufacturing Company.

L. R. Phillips has been appointed district sales manager of the **Detroit Seamless Steel Tubes Company**, Detroit, Mich., with headquarters at Chicago. Mr. Phillips has formerly represented the National Tube Company, at Chicago and St. Louis.

Items of Personal Interest

C. A. Kimmel has been appointed terminal master mechanic of the Union Pacific at Pocatello, Idaho.

T. F. Haynes, assistant engineer of motive power southwestern region of the Pennsylvania, with headquarters at Columbus, Ohio, has been promoted to assistant master mechanic of the Indianapolis division, with headquarters at Indianapolis.

H. N. Seely, general foreman, locomotive department of the Illinois Central, has been promoted to master mechanic with headquarters at Centralia, Ill., succeeding **C. M. Starke**.

W. J. Hill has been appointed supervisor of works equipment of the Atchison, Topeka & Santa Fe, Eastern Lines, with headquarters at Topeka, Kansas, succeeding **C. A. Brailler** who has been assigned to other duties.

Paul Maddox has been appointed superintendent of car department of the Chesapeake & Ohio with headquarters at Richmond, Va.

H. R. Voelker, assistant master mechanic of the Indianapolis division of Pennsylvania System with headquarters at Indianapolis, has been promoted to master mechanic of the St. Louis division with headquarters at Terre Haute, Ind.

Alfred E. Calkins has been appointed superintendent of rolling stock of the New York Central Lines, Buffalo and East, with headquarters at New York.

E. E. Wright has been appointed assistant division superintendent of Middle division of the Michigan Central with headquarters at Jackson, Mich.

H. G. Kastlin, master mechanic of the LaCrosse division of the Chicago, Burlington & Quincy with headquarters at Grand Crossing, Wis., has been transferred to the Creston division with headquarters at Creston, Iowa.

J. C. Bryan, superintendent of shops of the St. Louis, San Francisco with headquarters at St. Louis, Mo., has been appointed mechanical assistant to the manager of purchases of the American Short Line Railroad Association with headquarters at Chicago.

H. Moddaff, superintendent of shops on the Chicago, Burlington & Quincy, with headquarters at Aurora, Ill., has been promoted to assistant superintendent of motive power, Lines West of the Missouri river, with headquarters at Chicago.

J. A. Carney, superintendent of fuel economy of the Chicago, Burlington & Quincy with headquarters at Chicago, has been promoted superintendent of Shops with headquarters at Aurora, Ill.

Hugh Pattison, has been appointed engineer of electric traction of the Virginian. He was formerly employed on the electrification of the Illinois Central.

J. A. Carmody has been appointed superintendent of electric equipment of the New York Central, succeeding **C. H. Quereau**, who has resigned.

O. D. Bizzell has been appointed assistant superintendent of shops of the Atchison, Topeka & Santa Fe at San Bernardino, Cal.

C. K. Woods has been appointed assistant superintendent of motive power of the Pere Marquette, with headquarters at Detroit, Mich. He was formerly master mechanic at Saginaw, Mich.

C. W. Robertson, master mechanic of the Chicago, Burlington & Quincy at Creston, Iowa, has been transferred to Grand Crossing, Wis., in the same capacity.

C. F. Willoughby, formerly mechanical inspector of the Pere Marquette at Detroit, Mich., has been promoted to master mechanic at Saginaw, Mich.

Obituary

John G. Rodgers, vice president of the Northwestern region of the Pennsylvania with headquarters at Chicago, died suddenly at Camden, S. C., on April 11, while on the golf links. Mr. Rodgers' entire service has been with the Pennsylvania.

Stuyvesant Fish, formerly president of the Illinois Central and prominent in railroad financial affairs up to his death, died suddenly of heart disease in the National Park Bank, New York City, on April 10 at the age of 72. He was born in New York on June 24, 1851, and was graduated from Columbia in the class of 1871. He became a clerk in the New York office of the Illinois Central Railroad with which so much of his later life was to be identified, and after a time became secretary to the President of the road. He showed considerable ability, and when the banking house, Morton, Bliss & Co., offered him a job he left railroading for a time and served three years as a clerk. While still connected with this firm he became a member of the New York Stock Exchange, and about the same time was elected a Director of the Illinois Central and appointed Treasurer and Agent for the Purchase Committee of the New Orleans, Jackson & Great Northern Railroad. In the Fall of 1877 he became Secretary of the Chicago, St. Louis & New Orleans Railroad and soon after that was made Vice President of that road, which was a part of the Illinois Central system. His rise to power in the Illinois Central came fast after that. He became Second Vice President of the road in 1883, a year later was elected First Vice President and in May, 1887, became President.

Books, Catalogues, Etc.

The Earning Power of Railroads, by Floyd W. Mundy. The well known bond and brokerage house of Jas. H. Olyphant & Co., New York, has just issued the seventeenth edition of this book which they publish annually, and which will appeal to the banker, statistician, railway officer and in fact to all who are interested in the financial status of earning power of railways. One section gives a historical outline of the physical property and financial structure predicated thereon, while in another there is presented, in tabulated form, detailed statistics of mileage, capitalization, income, expenses, value of traffic handled, etc. Another section of this edition, chapter thirteen on Consolidation of railroads, is of particular interest at this time. It shows a proposed grouping of the railways into 19 groups of systems. This problem being one that is now, and will for some time to come continue to draw heavily upon the best minds in the railway executive, banking and legislative field, and will of course afford much material for political use. Anyone interested in the financial problems of our railways should be in possession of a copy of this volume.

An investigation of the Fatigue of Metals. Series of 1922 by H. M. Moore and T. M. Jasper, has just been published by the Engineering Experiment Station of the University of Illinois under the title of Bulletin No. 136. This is the second report to be issued of the investigation of the fatigue of metals carried on at the University of Illinois in co-operation with the National Research Council, Engineering Foundation, and the General Electric Company. Since the publication of the previous report in Bulletin No. 124 a considerable amount of additional test data has been obtained for specimens subjected to reversed stress. The tests of specimens in reversed flexure were made on the same machine as was used for the tests recorded in the earlier bulletin; no new kinds of steel have been tested since its publication, although a number of different heat treatments have been used. Test data from the local laboratories as well as from other laboratories are given for the endurance limit for wrought ferrous metals under reversed stress, and the evidence for the existence of such a limit is summarized. Various miscellaneous tests and test results, such as tests under reversed shearing stress and the effect of speed of stress reversal, are reported. An extensive study, which includes a discussion of the Goodman diagram for the effect of range of stress on the fatigue of metals, has been made of the resistance of metals to repeated stress other than reversed stress. Several of the unsolved major problems in the fatigue of metals are enumerated and briefly discussed.

Copies of Bulletin No. 136 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

The Cleveland Worm and Gear Company of Cleveland, Ohio, have issued an attractive catalogue setting forth the merits of their worm reduction gear for the driving of machinery. The gear is intended for use where there is to be a considerable reduction from a high initial rate of revolution to that needed in shop operation, as from a turbine or electric motor. In its construction the worm is made integral with the worm shaft from an alloy steel forging, that is case-hardened and ground all over. It is mounted on ball bearings with a thrust bearing of generous size. The wheel is built up of a hard phosphor bronze rim keyed to and shrunk upon a cast iron center. The wheel is then hobbed.

The housing is carefully machined so that when set up, the bearings are in alinement and there is an ample reservoir for the oil bath in which the worm runs.

Where the radiating surface of the housing is not sufficient to carry away the heat developed, a water jacketed oil well is used. In this the water enters one side of the housing, circulates through baffle passages around the oil well and emerges at the opposite side.

The efficiency of a worm and wheel is dependent upon the lead angle of the worm thread, the character and relative hardness of the materials in contact and other matters. With the Cleveland type of worm gearing, and with the angles as low as 20 degrees, the efficiency will be about 90 per cent, while with angles of worm of from 25 to 45 degrees the efficiency will range from 92 to 97 per cent.

The catalogue is illustrated with numerous reproductions of photographs of practical applications.

The growth of the worm gear drive in motor truck propulsion is given in a table showing the percentages of the several methods of driving as applied during the period from 1915 to 1922, inclusive. In 1915, for instance, the chain gear drive was applied to 58 per cent of all motor trucks manufactured, but in 1922 it had dropped to 3.9 per cent, while, on the other hand the worm gear had risen from 22 to 72 per cent.

Here are 32 pages of tables with illustrations giving the dimensions of the various gears that are manufactured by this company and their horsepower rating which ranges from less than one to 650, dependent on the type and rate of revolution of the worm. In the course of this rating some of the worms are set to run at a speed of 4,000 revolutions per minute.

The ordinary rating of the maximum speed of pitch line velocities to 600 feet per minute for worm gearing seems to have been set at naught by this gearing, which has been run at a speed of 3,600 feet per minute under continuous twenty-four hour service. over a period of years. This makes it very valuable for turbine reduction.

The latter part of the book is occupied by a number of tables that will be of value to engineers who have to do with gearing. These include the strength and horsepower of shafting: the bending moments, shear and deflection; the formula for combined bending and twisting moments; the angular twist of shafting; various horsepower formulæ for motors, gasoline engines, pumps and steam engines; rules and formulæ for the dimensions of spur and worm gears; general dimensions of gear wheels; tables of pitch diameters for circular pitch gems; equivalent values of electrical mechanical and heat units, and closing with some useful formulæ in proportions for converting from one unit to another.

The whole catalogue consists of 104 pages, measuring $7\frac{1}{2}$ in. by $10\frac{1}{2}$ in. It is printed on heavy cream paper and bound in a heavy cover.

Railway and Locomotive Engineering

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Electric Welding in Railway Shops

Its Application and Use in Locomotive Construction and Repair

By W. E. SYMONS

The actual saving in dollars and cents plus other resulting economies such as the reduction in time for renewals and repairs, restoring worn or broken parts, etc., through the application of thermit welding, electric and gas welding and cutting in railway, industrial and marine fields, will run into the stupendous figures of hundreds of millons of dollars.

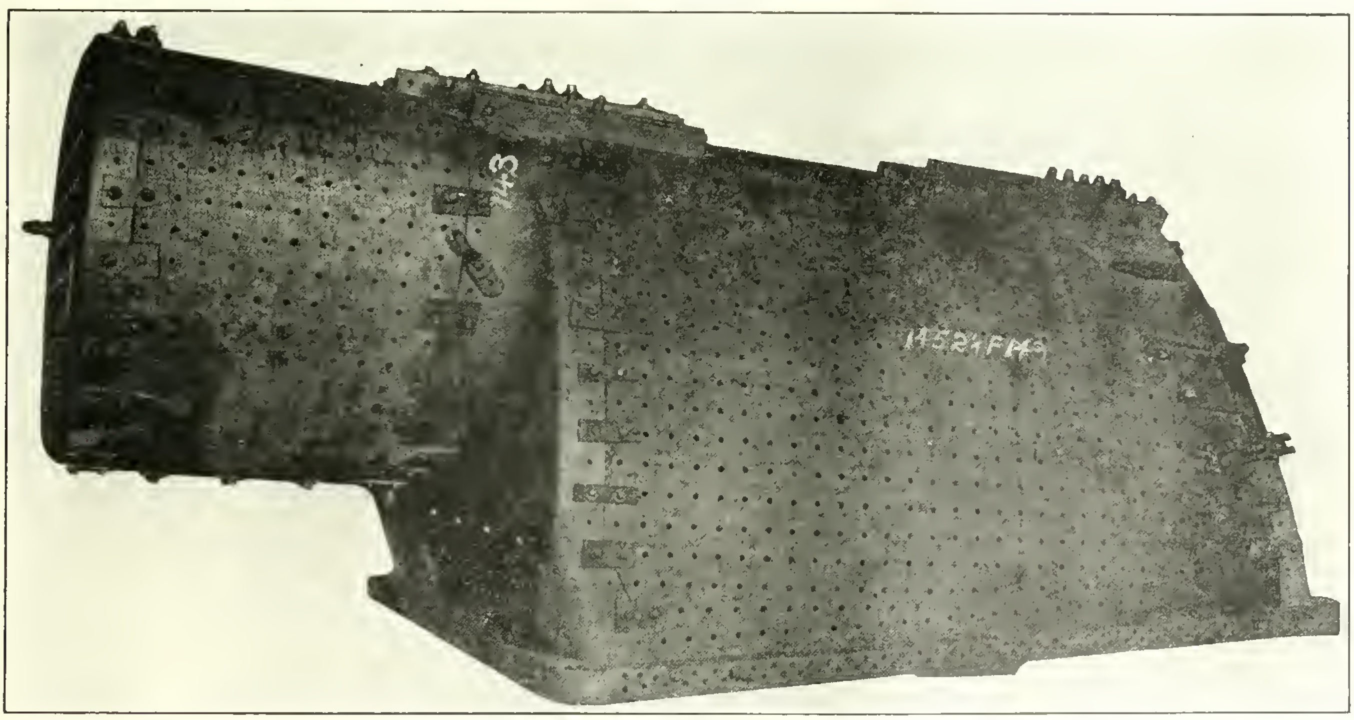


Fig. 1 Showing a Complete Firebox, Combustion Chamber and Flue Sheet Bolted and Clamped Together Ready for Electric Welding

The purpose of this article is to show the importance and value of electric welding in the construction and maintenance of railway equipment, and we expect to present in a future issue the application and use of the thermit and gas methods.

Earlier History of Welding

Electric welding by the antogenous process has only been successfully applied in modern times, although welding as an art no doubt dates farther back than most engineers or mechanics may think it has been practiced.

Electric welding was successfully accomplished in the United States by Elihu Thompson along about the year 1877, or 46 years ago. His system or method, however, is what is known as the pressure or butt welding process, and in reality is confined largely to a field unto itself. That the art of welding is one of the earliest discoveries of man seems to be supported by quotations from a number of very reliable authorities on the subject.

In the work of Dr. L. A. Groth, we find the following quotation from a paper by Mr. Harry Ruck-Keene read at the Engineering and Machinery Exhibition in London, September, 1907:

"The ordinary form of welding can certainly not be called a new process, for though I have been unable to find who is the first discoverer of the art of welding, yet on referring to the fourth Chapter of Genesis, I find that Tubal Cain (who lived about 3,950 years before Christ) is there described as an instructor of every artifice in brass and iron!"

So we may fairly conclude that the ordinary form of welding was known in those days; but to come down from the days of Tubal Cain to more modern times, it was the practice of several well known firms in making iron boilers to weld the longitudinal seams of the shell plates instead of riveting them, and in 1874 some exhaustive tests then made proved the efficiency of these welded seams to be 70 per cent of the solid plate. The article by Dr. Groth, then described in detail repairs made to modern boilers, both by the oxy-acetylene and electric welding processes.

Baldwin Locomotive Works Leaders in Electric Welding

Among those who first recognized the great value of electric welding in the construction of locomotives was The Baldwin Locomotive Works of Philadelphia, whose business has grown from the little Ironsides of 1832 which had cylinders 9½ x 18 ins., steam pressure of 55 pounds and total weight of 11,000 pounds, to an annual output capacity of 2,000 engines, the volume of business measured in dollars having exceeded $123,000,000 in one of their most prosperous years.

While some were theorizing on the application of electric welding in locomotive work, and others were using it in a more or less experimental or half hearted way, the Baldwin people under the leadership of their aggressive president, Samual M. Vauclain went right to the heart of the subject and immediately produced results that have no doubt added materially to the profits of his company, and to the economic value of locomotives to their purchasers.

The system of electric welding in boiler construction had been so successfully standardized by the Baldwin people that they issued a booklet on the subject some time ago from which we quote the following:

"Electric arc welding is the transformation of electrical energy into heat through the medium of an arc for the purpose of melting and fusing together two metals. The metal to be welded is made one terminal of the circuit, and other terminal being the electrode. By bringing the electrode into contact with the metal and instantly withdrawing it about ⅛ in., an arc is established between the two. As more heat is generated at the positive than at the negative terminal, the work to be welded is made positive."

The metallic electrode is used almost exclusively in locomotive work, the carbon electrode being used only for burning the sand out of the holes in steel castings, preparatory to burning out such holes with a metallic electrode, and for cutting purposes. The metallic electrode should be a mild steel wire showing on analysis about 0.18 per cent carbon, manganese not exceeding 0.5 per cent and with only a trace of phosphorus, sulphur and silicon.

It is very desirable that a short arc be used in welding in order that the metal being carried from the electrode to the work shall not be oxidized and thus produce a porous weld. In order to produce a short arc, the voltage across the arc should be from 20 to 30 volts, depending on the amount of current required.

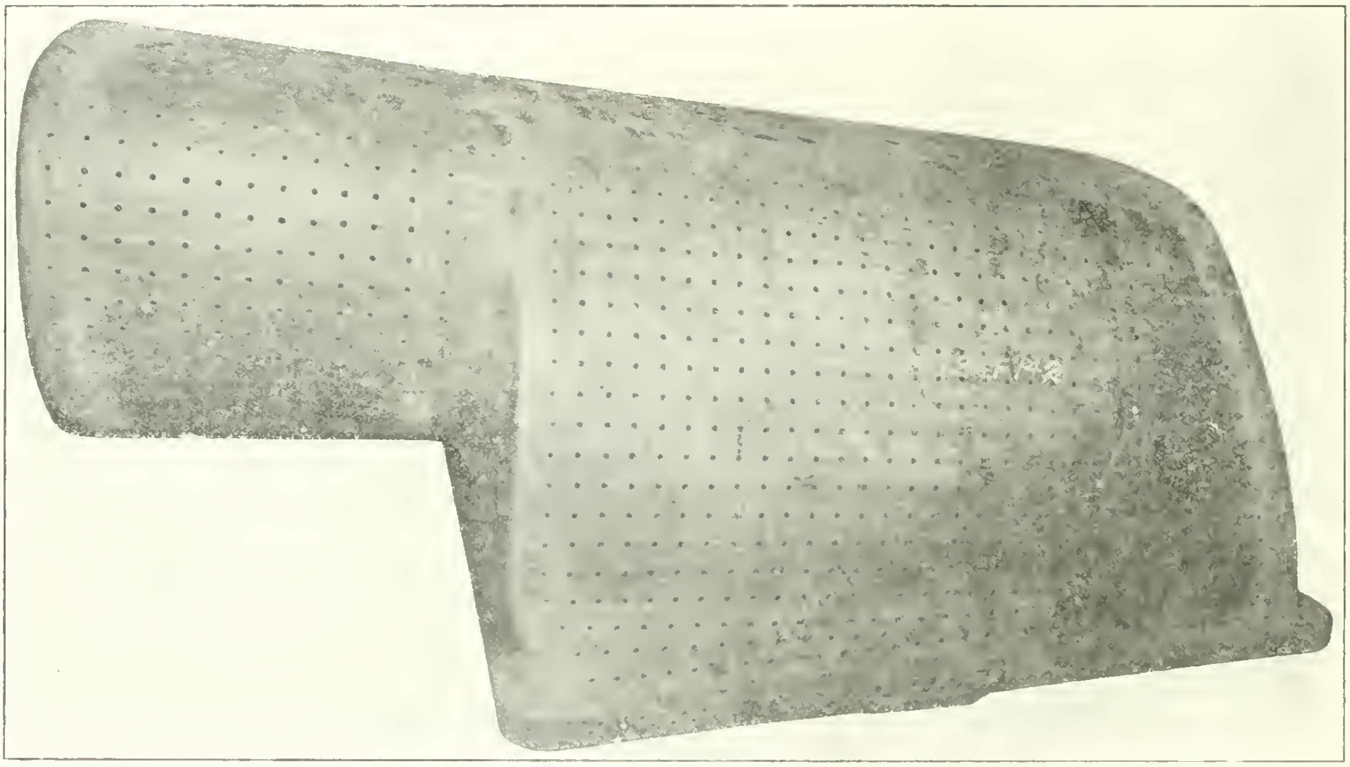


Fig. 2. Electric Welded Firebox Complete

The value of current to be used to obtain the best results depends largely on the thickness of the plates to be welded. In boiler and firebox work the welding current varies from 150 to 175 amperes.

Electric Welding in Locomotive Shops

Electric welding is now very generally used in the locomotive building and railway shops of the United States, and is recognized as a leading feature of economy. In boiler construction and repair it insures steamtight joints at seams and tube ends, and in many cases it entirely eliminates riveted joints by substituting direct union between the edges of the sheets to be joined. This latter feature is particularly useful in the construction of fireboxes and combustion chambers where the joints are subjected to direct contact with flaming gases. Tube ends when welded to the firebox sheet can be kept tight under all service conditions.

The methods of welding boiler joints are now so well established that positive results are assured as the process is entirely beyond the experimental stage. Illustrations of these operations are photographic records of actual accomplishments, and as such are representative of the progress of the art.

An important economy is found in the use of electric welding for the reclamation of castings and forgings showing minor defects or variations from dimension, and in the replacement of worn surfaces on parts in actual service. Salvage of this character means more than the direct saving in cost of material: the gain over time required for complete replacement is frequently a factor of greater economic importance.

Locomotives to earn revenue must be kept as far as possible in continuous service, long delays in the repair shop must be avoided. By the use of electric welding many repairs are made possible without complete dismantling or complete withdrawal from service: the revenue-earning value of the locomotive is thus considerably increased.

The work that can be accomplished by electric welding covers so great and various a field that the scope of this article can cover only a few of the usual operations. These are set forth by description, illustration and under detail headings:

Patching Flue Sheets

Cracked, warped and mud-burned flue sheets in condition formerly requiring complete replacement are now readily repaired by electric welding and without removal from the boiler. The damaged portion is cut out and a sufficient number of flues removed to allow the welding operator room to work on the inside as well as the outside of the sheet. A patch of new plate is clamped into the opening made by the removal of the damaged portion. A clearance of 1/16 in. to ⅛ in. is allowed between the edges to be welded, and in this space a weld is made with the metallic electrode, first from one side and then from the other until a perfect union of the metal is accomplished. The patched sheet is then re-drilled and the tubes re-fitted, making the locomotive again ready for service without the long delay incident to applying an entirely new sheet. If desired, the flues themselves can be welded into the flue sheet according to the following general insructions:

Welding Flues to Flue Sheet

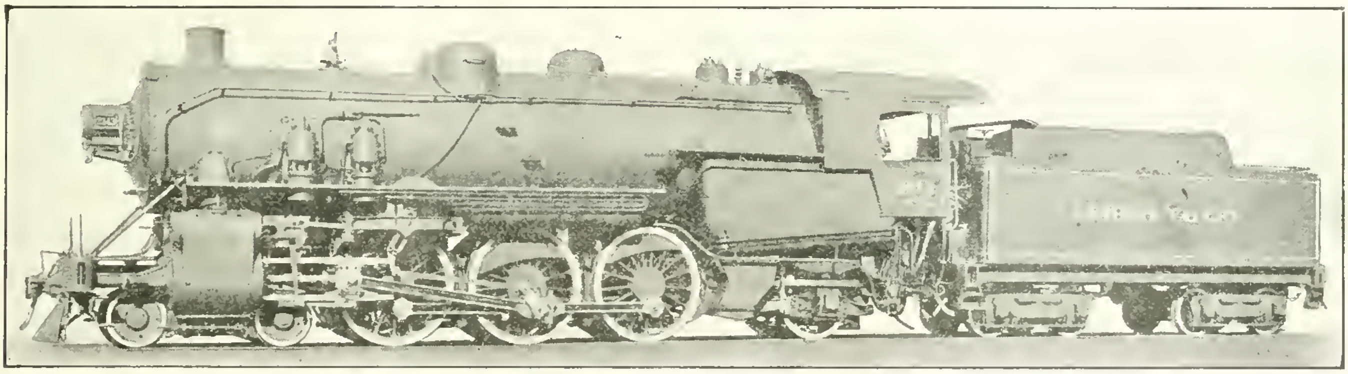
All flues should be thoroughly cleaned by sand blast before welding. Old flues should be re-set with standard expanding and beading tools.

In preparing new flues and newly pieced flues for welding, the sheet should be cleaned thoroughly by sand blast after the flues have been expanded and before the flues are beaded. After the sheet is cleaned, the flues should be beaded without the use of oil or any other kind of lubricant.

The welding operator should be held responsible for the sheets being perfectly cleaned before starting to weld.

Welding should be done with the boiler filled with water. All flues should be made perfectly tight before the welding is attempted. In case of new flues and newly pieced flues, the water should be put in the boiler after the flues have been expanded, and they should be made tight before they are beaded. All the superheater flues should be welded first, starting with the top row. The remaining flues should be welded by starting at the top row and working downward. Each flue should be welded by starting at the bottom and welding up on one side and then on the other, completing the weld at the top of the flue.

Welding one flue forms a deposit on the adjacent flue beads and sheet: before starting to weld one of these adjacent flues, all such deposits must be removed with a wire brush.



Pacific or 4-6-2 Type Locomotive of the Lehigh Valley Railroad. This Locomotive Has All Firebox and Combustion Chamber Seams Electrically Welded

While welding, the work should be watched very carefully by the operator, so that if there is any indication of improper fusing of the metal, it can be cut off immediately and re-welded.

Flues should be welded with ⅛ in. wire.

After welding, the joint should be tested by a hydrostatic pressure of 25 per cent in excess of the boiler pressure. If there is any leakage, the weld should be cut off and the flue re-set and re-welded.

Boiler Repairs to Locomotives in Service

When removing welded flues, the old weld should be cut off and the sheet carefully prepared for the new flue. Rolling, expanding and beading should be done by standard methods, after which the flue should be welded in and tested. If no welding machine is available at the point of repairs, the engine can be placed in service after the new tube has been set and beaded in the ordinary manner, the final operation of welding being left to the first opportunity.

When welding cracks that occur between stay-bolts the bolts should first be removed and the cracks chipped clean with a diamond-point chisel. After welding is accomplished, the stay holes must be retapped and new stay-bolts applied in the usual manner.

Boiler check joints and other similar ground joints that have become so cut and pitted that they can no longer be ground to a surface can be readily repaired by welding. The bad spots can be cut out with a diamond-point chisel, the metal cleaned and a new surface built up for re-grinding.

Training an Operator

Training an operator usually requires comparatively short time, as any man of average intelligence can become a skilled operator in from three to six weeks of

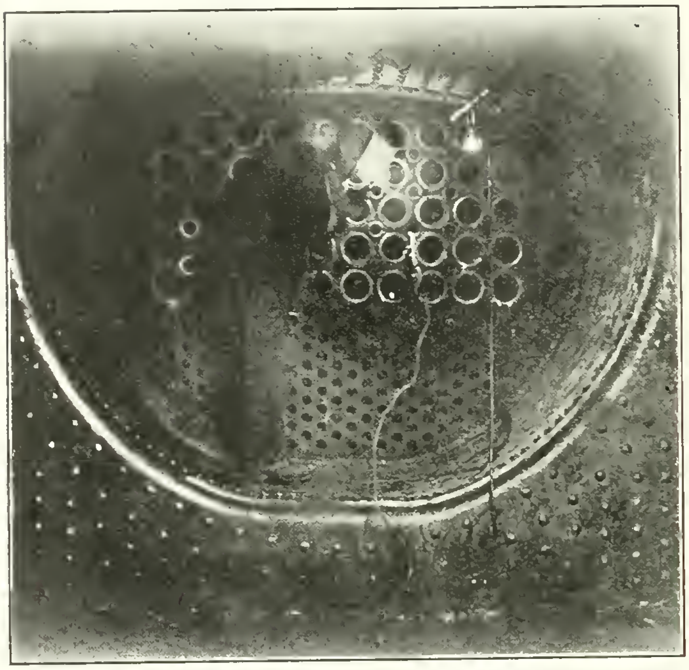


Fig. 3 Shows Firebox With Electric Welding Operator at Work

conscientious practice. The first exercise consists of welding together scrap pieces of metal to learn the correct manner of holding the electrode to form a proper arc between it and the metal to be welded.

When practicing flue welding, the operator should use a short piece of tube or a piece of sheet metal rolled to represent a flue. This can be inserted into a piece of plate representing the flue sheet. The importance of cleanliness should be impressed on the beginner: without clean metal perfect welds are impossible of accomplishment.

Following the proper instructions, the operator readily perceives that the welding of boiler seams and flues is a comparatively simple process, and with confidence once gained, soon becomes expert in the art.

Electric Welding Accomplishments

Examples of what can be done by electric welding are shown in the illustrations. Figs. 1 to 5 inclusive, show boiler and firebox work in its several stages. Fig. 6 shows methods to be followed in firebox welding repairs.

Welding Cast Iron—Electric Arc Method

Doubtless most of our readers, who are interested in this subject know of the great value of welding broken locomotive cylinders, and quite a few may recall the use of and great economies resulting from its use on the restoration of damaged German ships in American ports during the late war, and even though this may not be news to some of our readers, we feel that a review of the repairs made on damaged cylinders will be quite interesting to those who specialize in locomotive work.

The Germans have made great strides in the arts and sciences, particularly so in scientific investigation in nearly all branches of engineering subjects and great credit is due them for what they have contributed to the engineering world; and we might add that Dr. Goldsmith, who discovered and developed thermit welding, is entitled to special recognition on that score.

In this particular case, however, the Germans did not reckon with the resourcefulness of the American engineer and mechanic. They also shared in the belief, still held by what is becoming more and more of a minority among the American engineers and mechanics, that cast iron could not be welded. Therefore, when they received instructions from Berlin to damage the machinery of their ships they selected the parts which they believed could not be restored either by engineering science or Yankee ingenuity, as was evidenced by the destruction of something like one hundred and eighteen essential parts of steam cylinders of the interned ships in the New York harbor.

These engine cylinders were restored under the supervision of the Navy Department of the United States Government, more than eighty major breaks being successfully repaired by the electric welding process, the work being done in about one-tenth the time and at about one-quarter the expense ordinarily required by other methods, the saving effected amounting to many hundreds of thousands of dollars. The best evidence that can be offered as to the satisfactory manner in which this work was completed would be to quote from the report of Commander Jessup, under whose direction the repairs were made.

"Scleroscopic investigation of the structure of the welds shows only a very slight vein of hard cast iron at the line of weld, shot through with fingers of gray cast iron, while behind this area there was no heat effect whatever. The metal thus deposited was easily

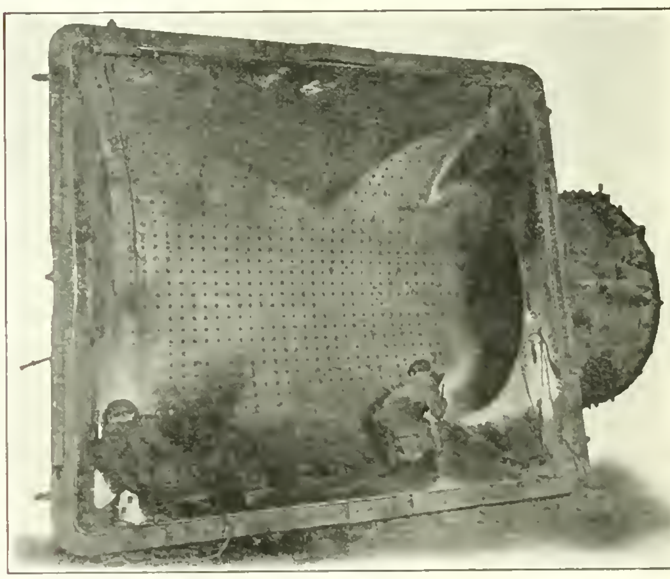


Fig. 4 Shows Firebox Placed on Side, with Two Operators Working From a Two-Arc Machine

workable with hammer and chisel, file or cutting tool. Another very important feature is that by the use of low voltage and absolute automatic current control there is a minimum of heat transmitted to the parts to be welded, this being practically limited to a heat value absolutely necessary to bring the electrode and the face of the metal to be welded into a semi-plastic state, thus insuring a perfect physical union, and in accomplishing this result neither of the metals suffers from excessive heat, and there is absolutely no necessity for pre-heating. Neither are there any adverse results from shrinkage, following the completed work owing to a minimum amount of heat being transmitted to the repair parts, thus avoiding the possibility of distortion of parts through uneven or excessive shrinkage strains that are very common where pre-heating is necessary or excessive heat is used for fusing metals."

From the foregoing it must be clear to any who

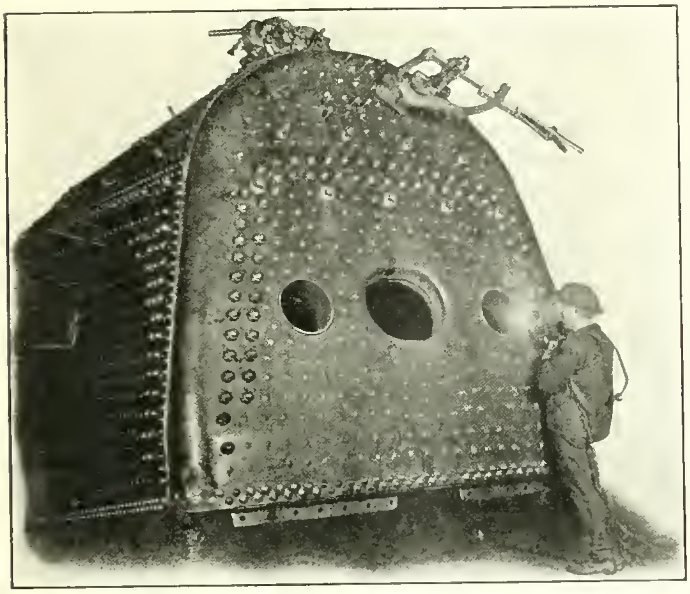


Fig. 5 Shows Method of Electrically Welding Openings in Back Head of a Firebox

might have been of doubtful mind, that the welding of these damaged cylinders was not only an important factor in winning the war but saved many hundreds of thousands of dollars, and that electric arc welding played an important part in the field of marine engineering.

Element of Doubt in Riveted Joints

To those who may still feel some degree of reluctance in extending the use of electric welding to boiler construction or repairs, and who may hold to the rather general belief of some time ago, that welded joints had hidden defects, while riveted joints were practically free therefrom, we would invite attention to some rather striking and what we consider very convincing examples favorable to the welded joint. The Figs. 7 and 8 show a comparison of riveted and electric welded joints. In Fig. 7, actual examples of defects in the former method are shown, and comparison of the two methods in locomotive boiler construction is shown in Fig. 8.

Comparison of Riveted Seam and Electric Welded Joint

Fig. 7 shows first, plate 5 x 20 ft. such as is ordinarily used in steel ship construction after it has passed through the operation of a punching machine, that punches 4,000 holes per day. In this particular instance there has been punched in this sheet 672 holes, the weight of the punchings being about 135 pounds; next below is shown a plate of the same size which has been prepared for the electric welding process. Between the two plates may be seen a typical butt joint riveted seam such as is commonly used in ship construction, while below is shown an electric welded joint.

The methods followed in the preparation of the first sheet and the assembly of the upper seam produces what is called an 85 per cent riveted butt joint seam, while the lower one produces a 100 per cent welded joint.

The tabulated data at the right of Fig. 7 gives some salient points of interest.

In a ship of five thousand tons for example, we find there are used in its construction 450,000 rivets and that there are approximately 70,000 lineal feet of joint or seam. The weight of steel used in a ship of this size is 3,600,000 pounds; and assuming that the weight of metal used in laps, rivets, welts, etc., essential to the riveted seam at 8 per cent, then the amount of metal for this purpose would be 114 tons or 288,000 pounds. At five cents per pound, this metal would be worth over $14,000. Increased cargo space would result from the elimination of a large majority of these riveted seams and the substitution therefor of electric welding would have a money value that should attract the attention of all efficiency engineers or managers. In a word, the riveted seam does not in all cases harmonize with modern engineering practices.

Examples of Defective Workmanship, Riveted Seam Method

Attention is invited to examples Fig. 7, A, B, C and D of defective workmanship in the construction of ships or other similar structures where the riveted seam method is employed.

Example B shows where lead filling was applied, where the holes in the two sheets did not come even. In the particular case in question a ship was built by a concern in England, and after it had been in service a year or so it was brought in for certain repairs and while standing at the dock or wharf the building adjacent thereto was destroyed by fire, the flames reaching across and burning the woodwork of the ship and all of the paint from the sides of the plates. After the

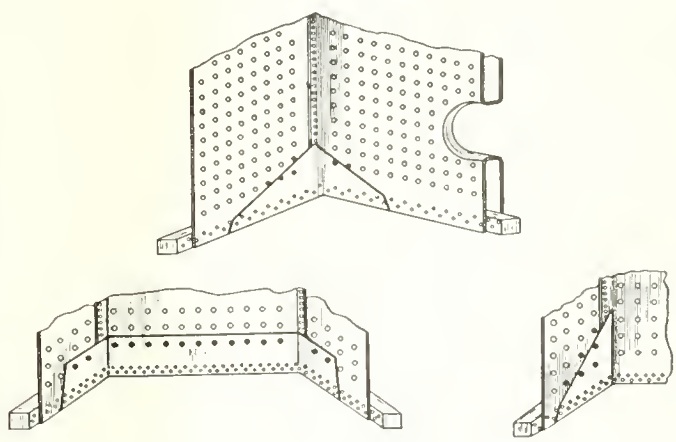


Fig. 6 Showing Methods to Be Followed in Firebox Repairs

fire was extinguished, it was noticed that the ship was striped all over its sides next to the wharf with vertical stripes. Upon examination, it was found that these stripes were from melted lead with which the holes had been plugged up on the sides of the ship in its construction by riveters who found it easier to follow this method than to re-ream the holes and apply the rivets as they should be.

To those who stick to the riveted seam for all purposes, and reject a welded joint on the grounds that it might be defective, this should serve as a striking object lesson.

Comparison of Riveted Seams and Welded Joints

Fig. 8 shows very clearly an amount of superfluous, or what may be termed, unnecessary metal in the production of an 85 per cent riveted seam as compared to what is necessary in producing a 100 per cent welded joint.

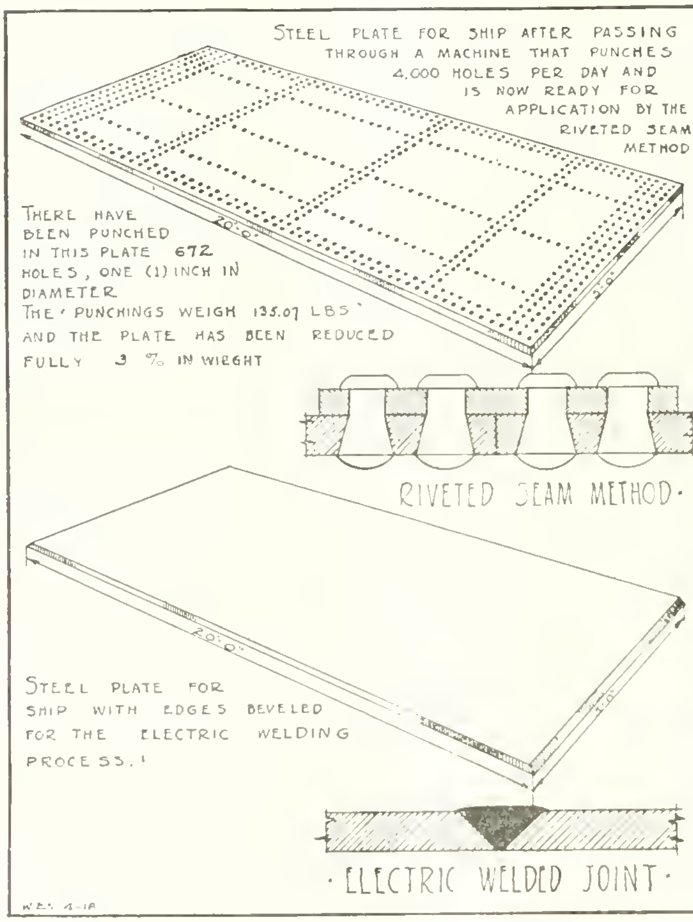
The top view shows what is ordinarily termed a lap seam, the second view a welded joint, and the third view a butt joint riveted seam; the fourth view to the left being a butt joint riveted seam, with double welt strips inside and outside; while to the right of this double welt seam is another electric welded butt joint.

Referring to the tabulated data, it may be observed that in 1917 there were built in the United States a total of 15,484 locomotive boilers and tanks combined. but to emphasize the fact that riveted joints that look 100 per cent to the eye are sometimes dangerously defective, while from the standpoint of quantity of material used they are certainly extravagant to the point of actual waste when compared to welded joints.

Electric Engineering

Engineering in its last or final analysis consists of the application of nature's forces to the uses of man, and he that can best adapt these forces to produce the greatest good to the greatest number is by this same standard the greatest engineer.

Electricity in itself is not the product of inventive genius but the result of discovery, it being one of nature's forces that a Divine Providence provided for man and which lay, slumbering as it were, in nature's



·MEMORANDA ON STEEL SHIPS

NO.	ITEMS	AMOUNTS
1	TONNAGE OF SHIP	5,0 00
2	NUMBER OF RIVETS	450,000
3	APPROXIMATE AVERAGE SPACING	3 INCHES
4	APPROXIMATE LINEAL FEET OF JOINT OR SEAM	70,000
5	WEIGHT OF STEEL PLATES IN SHIP IN POUNDS	3,600,000
6	TOTAL WEIGHT OF FINISHED SHIP READY FOR SEA POUNDS	4 400,000
7	COST PER TON IN NORMAL TIMES, $ 60 00 PER TON	$ 300,000
8	COST PER TON 3-1-17, $ 170 00 PER TON	$ 850,000
9	COST PER TON 4-1-18, $ 250.00 PER TON	$1,250,000
10	INCREASE FROM NORMAL TO 3-1-17	166 %
11	INCREASE FROM NORMAL TO 4-1-18	316 %
12	PERCENT OF WEIGHT IN LAPS AND RIVETS, 8 %	288,000 lbs
13	COST OF WEIGHT IN LAPS AND RIVETS @ 5¢ lb.	$ 14,400 00
14	144 TONS CARGO SPACE AT 8¢ PER 100 LBS	$ 2,304
15	EARNING VALUE PER YEAR (20 TRIPS)	$ 46,080
16	COST PER LINEAL FOOT · RIVETED SEAMS	
17	COST PER LINEAL FOOT TO WELD	
18	APPROXIMATE AMOUNT SAVED BY ELECTRIC WELDING	
19	MR HURLEYS PLANS FOR THIS YEAR CALL FOR	5 500,000 TONS
20	MR HURLEYS PLANS FOR NEXT YEAR CALL FOR	7,000,000 TONS
21	SAVING IN COST BY ELECTRIC WELDING ??	MILLIONS
22	SAVING IN TIME AND EFFICIENCY BY ELECTRIC WELDING	MILLIONS
23	THE RIVETED SEAM "DOES NOT" HARMONIZE WITH MODERN ENGINEERING PRACTICE ??	

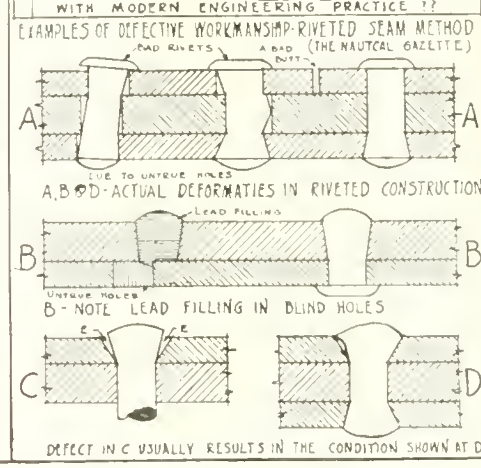


Fig. 7. Comparison of Riveted Seam and Electric Welded Joint with Examples of Defective Workmanship

Placing the weight of these boilers at 60,000 pounds, and tanks at 15,000, the combined weight is 571,200,000 pounds. There were used in their construction approximately 28,655,000 rivets and if the percentage of metal necessary in a riveted seam is as much as twelve per cent in locomotive boilers, and six per cent in tanks, then the weight of extra metal necessary for these riveted seams amounts to over 61,000,000 pounds, and at 5 cents per pound, would cost more than $3,000,000.

Based on the above estimate as to the amount of metal required in riveted seams, this would be equal to the weight of 875 locomotive boilers and 345 tanks, or a total of 1,220 units. The field is certainly an inviting one to those interested in modern efficiency methods.

The purpose of the foregoing is not to cast discredit on good mechanically honest riveted seams or joints

great storehouse ages and ages awaiting man's advancement in the fullness of time to a higher plane when he only had to simply tap this great source of power and take therefrom without money or price.

All of the natural elements were in existence when Adam and Eve were in the garden of Eden, and a few thousand years later in the time of King Solomon and Julius Caesar, for them to have had telephones, electric bells, telegraph lines, automobiles, aeroplanes, electric trucks, electric railways and electric welding, but man had not yet developed to a point where these forces were essential to his existence or prosperity.

The answer, or reason for this, however, is quite clear when we reflect that the great transportation chiefs of that period amassed great fortunes, lived in luxury, gave the public all they wanted in the way of safe, and what they termed swift transportation, at a satisfactory rate and were able to operate with prime movers that cost from only a few dollars to as low as about 2 cents each, while the compensation of employees was less than 15 cents per day, that of many being less than one cent per day. Manifestly there was no incentive or necessity to seek means of increasing net earnings from operations, or attaining greater speed.

It has long been known to engineers and also to mechanics, particularly the blacksmith and boiler maker, that there is a critical heat to all metals at which they may or may not be safely worked and this is particularly true as to steel, in fact it is still a watchword or slogan among the boiler making fraternity, to be sure and never attempt to flange a steel sheet or plate at the "dangerous blue heat." This is a danger signal which stands as a warning before the eyes of every boilermaker from the time he takes up his occupation or profession until he ceases to follow it. The blacksmith is also trained in a similar way with respect to the critical heat at which metals can be properly welded, and above everything else he has always been guarded against burning it or attempting to weld at a too low temperature, yet in view of all of these facts and the additional information which comes to the users of electric welding through experience, many continue to restore parts that are beyond repair and should be replaced with new material, consequently it is not strange that there are failures, which have a tendency to discourage the further introduction of the art. All of these features are, however, of easy solution.

In summing up we wish to again refer to certain fundamentals essential to success.

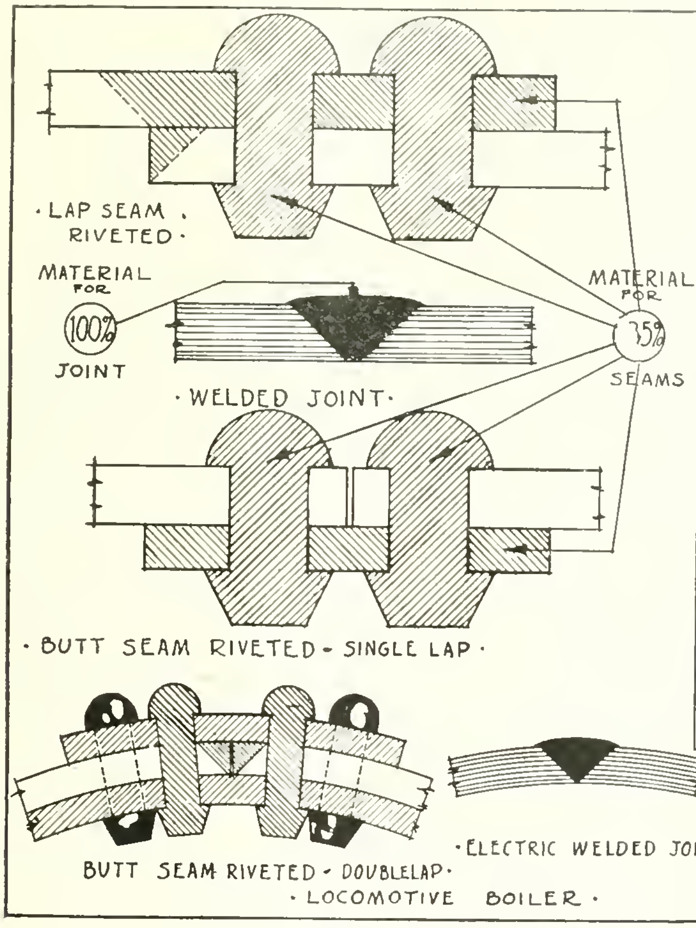
First: Any weldable metal can be welded with a system which employs proper heat values and proper current control together with a welding metal suitable for the work, and a competent welder.

Second: With too high voltage, lack of current control, poor operator and general run of electrodes, simply called good iron, welds made will abound with such defects as voids, craters, slag pockets and lumps crystalline in character, all or any of which render the weld defective.

Third: Do not attempt impossible or unmechanical things no matter what kind or type of welding system is involved, for failure is sure to follow; and finally:

If any there be who feel that they have a monopoly of either welding or cutting, and have completely covered the field to the exclusion of all others, we beg to remind them of the fact that when Alexander the Great sat down and wept that there were "no more worlds to conquer," he had only just scratched a little around the edges of the habitations of man.

In a future issue we hope to give our readers additional information on the progress of the art, including both the gas and thermit methods which have also made wonderful progress in the same or similar fields.



TABULATED DATA ON LOCOMOTIVE BOILERS AND TANKS FOR TANK CARS

NO	ITEMS	LOCOMOTIVES AND TANKS			REMARKS
		LOCOMOTIVE BOILERS	TANKS FOR TANK CARS	TOTAL 1917	
1	NUMBER BUILT, 1917	7642	7,842	15,484	
2	WEIGHT IN POUNDS (AVERAGED)	458,520,000	112,600,000	571,200,000	BOILERS 60,000 TANKS 15,000
3	NUMBER OF RIVETS USED	13,755,600	14,899,800	28,655,400	BOILERS 1,800 TANKS 1,900
4	LINEAL FEET OF RIVETED SEAMS	2,674,700	3,136,800	5,811,500	
5	WEIGHT OF RIVETS LAPS AND WELT STRIPS USED IN RIVETED SEAMS	55,022,400	6,756,000	61,778,400	BOILERS 12% TANKS 6%
6	COST OF RIVETS, LAPS AND WELT STRIPS (ESTIMATED 5¢ LB)	$2,751,120	$337,800	$3,088,920	5¢ PER LB.
7	AVERAGE COST PER FOOT FOR MATERIAL RIVETED SEAMS	$1.09	$10.76	$3,088,920	AVERAGE 53¢
8	AVERAGE COST PER FOOT FOR MATERIAL, ELECTRIC WELDED JOINT	8.8¢	5.5¢	$378 575	BOILERS. 8LBS PER FOOT TANKS. 5LBS PER FT
9	WEIGHT OF METAL FOR ELECTRIC WELDED JOINTS	2,139,760	1,568,400	3,708,160	
10	SAVING IN COST OF BY ELECTRIC WELDED JOINTS	$2,515,747	$165,276	$2,681,023	
11	REDUCED WEIGHT BY ELECTRIC WELDING	52,882,640	5,187,600	58,070,240	
12	ANNUAL SAVING ON REDUCED WEIGHT AT 3 MILLS PER TON MILE	$2,379,690	$77,790	$2,457,480	ENGS 30,000 MILES CARS 10,000 MILES
13	UNITS IN KIND THAT COULD BE BUILT FROM SAVING IN ITEM (11)	875	345	1220	
14	SAVINGS IN COST ITEMS (6 AND 12)	$4,895,437	$243,066	$5,138,503	
15	NEW ENGINES AND CARS SAVINGS IN ITEMS (6 & 12) WOULD PURCHASE	97	69	166	ENGS $50,000 CARS $3500.
16	PER CENT OF TIME SAVED IN CONSTRUTION BY ELECTRIC WELDING	50	50	50	
17	TIME SAVED IN MAINTENENCE OR REPAIRS BY ELECTRIC WELDING	60-90	60-90	60-90	

Fig. 8. Comparison of Riveted Seams and Welded Joints with Tabulated Data

New York Electrification Bill Becomes a Law

All railway lines within the city limits of New York City must be electrified before January 1, 1926, according to an act by the legislature which was signed by the Governor last Saturday, in spite of the protests of the railways affected. These are the New York Central, the New York, New Haven & Hartford, the New York Connecting, the Long Island, the Staten Island Rapid Transit and the Baltimore & Ohio—in addition to the New York piers of several other roads.

The Virginian Railway Electrification

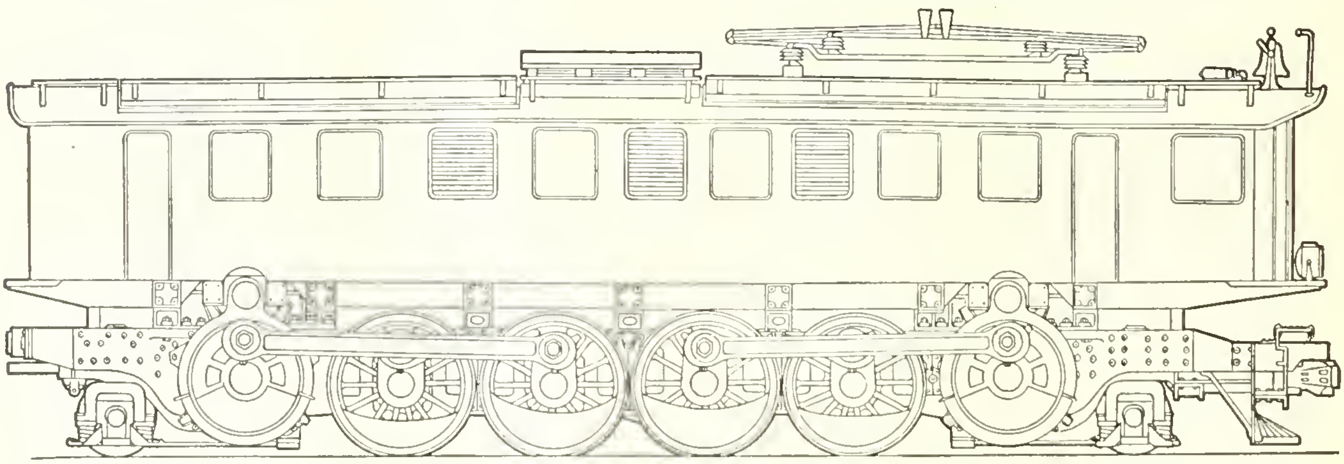
By R. L. McClellan, Westinghouse Electric & Manufacturing Company

The Virginian Railway has contracted for one of the biggest electrification projects ever undertaken in America, which as an indication of the trend of railroad expansion is of the greatest importance. Coming as the first great railroad improvement of its size or kind since the beginning of the World War, unusual importance is attached to the selection of system, the plan of operation, and the general policy of electrification.

The electrification covers the main line of the Virginian Railway from Mullens, West Virginia, to Roanoke, Virginia, a total of 213 miles of track, and includes the grades over the Allegheny mountains. The project provides for handling all freight electrically, involves the construction of a large steam generating station, transmission lines, an overhead trolley system and a number of electric locomotives, and makes provision for material increase over present traffic capacity. The undertaking involves an expenditure of $15,000,000. The contract for all equipment has been awarded to the Westinghouse Electric & Manufacturing Company and the alternating-current single-phase system is to be used.

The Virginian is now moving, from Mullens, West Virginia, to Norfolk, about 7,000,000 tons of coal per annum. This movement is made in trains of approximately 5,500 tons trailing up the west slope of the mountains at a train speed of about 7 miles per hour and thence down the east slope of the mountains and to tidewater in trains of 6,000 tons trailing. With electric operation trains of 6,000 tons trailing will be moved up the west slope of the mountains at 14 miles per hour and will be filled out there to 9,000 tons for movement to tidewater. The initial operation will be laid out for an annual movement of 8,000,000 net tons of coal and the system will be designed to have a capacity for handling more than twice this amount. The higher train speeds and the greater amount of power which can be applied to an individual train will enable the movement of more than twice the present tonnage over the existing permanent way.

The facts that the electric locomotives will be available for service during a far greater portion of the time than the present steam equipment, that the cost of maintenance for electric locomotives is far less than for steam and the more efficient production of power in a stationary plant as compared to a locomotive will result in very material economies.



Type of Motive Power Unit Being Built for the Virginian

The Virginian Railway, built by the late H. H. Rogers, extends from Deep Water, West Virginia, through the rich Pocahontas and New River coal fields to tidewater at Norfolk. It is pre-eminently a coal road with a heavy eastbound traffic, a large majority of which is coal. The railway has long been recognized as a leader in the movement of heavy tonnage and in the operation of immense trains and the use of large locomotives. The Virginian first became conspicuous for what was then referred to as its extravagant policy of designing, building and equipping for the movement of tonnage materially in excess of what then appeared to be reasonable expectations. "Roger's folly," as it was then called, has since been vindicated and the faith of its founders in American railroading has made possible a degree of success in operation and which is today the envy of many a major railroad in America. The Virginian has, in late years, been conspicuous for its 120 ton coal cars, the use of super powered locomotives, the operation of 8,000 ton trains and the development of a coal pier at tidewater of astounding proportions, and is now establishing a new claim for leadership in undertaking an electrification, the largest of its kind in the world.

The principal objects of this undertaking are two: first, the expansion of its traffic handling capacity, and, second, the improvement of operating efficiency or reduction in ton mile costs.

The system adopted is the alternating-current single-phase system with an overhead trolley similar to that used with such success on the Norfolk & Western, New York, New Haven & Hartford, the Pennsylvania Railroad at Philadelphia, the Grand Trunk, the Boston & Maine Railroad, the Erie Railroad, the Spokane & Inland Railway and the Chicago, Lake Shore & South Bend Railroad.

Each locomotive will have the following characteristics:

Total weight approx	600 Tons
Weight on drivers	450 Tons
T. E. Continuous	135,000 Lb.
T. E. Maximum	277,500 Lb.
Speed	14 or 28 MPH
Horsepower continuous at 14 MPH	5,115 Hp
Horsepower continuous at 28 MPH	5,970 Hp
Diameter of drivers	62 In.
Length over coupler knuckles	145 Ft. 8 In.

The locomotive will receive current from an 11,000-volt trolley wire through pantagraph collectors; this current will be stepped down by transformers in the locomotive cabs to a low voltage and delivered to the phase converters which will convert this single phase to three-phase current for use in the main motors.

The main motors, six in number, will be of the induction type with wound rotors, controlled by liquid rheostats in the secondary circuits. The use of induction motors provides a ruggedness and simplicity of construction and a dependability of operation which characterize this type of motor and does away with the use of commutators.

Power is transmitted through gears and pinions to jackshafts, which are connected to the drive wheels by side rods. There are six such motors and six jackshafts per locomotive, each connected to two driving axles. This design enables mounting the motors above the locomotive frame, and the use of side rods makes possible the use of the entire weight on drivers for adhesion, thus making possible a tractive effort in excess of that possible with individually driven axles.

A feature of the system adopted is its unusual capacity for regenerative braking. It has long been recognized that in such an operation as that of the Virginian one of of the most serious problems is that of controlling trains while descending steep grades. This will be accomplished in this case entirely by regenerative braking, the air brakes being held entirely in reserve for emergency use. With the type of motor and the system adopted the full capacity of the locomotives is available for holding on down grades and this permits holding a heavier load descending a grade than can be handled up the same grade.

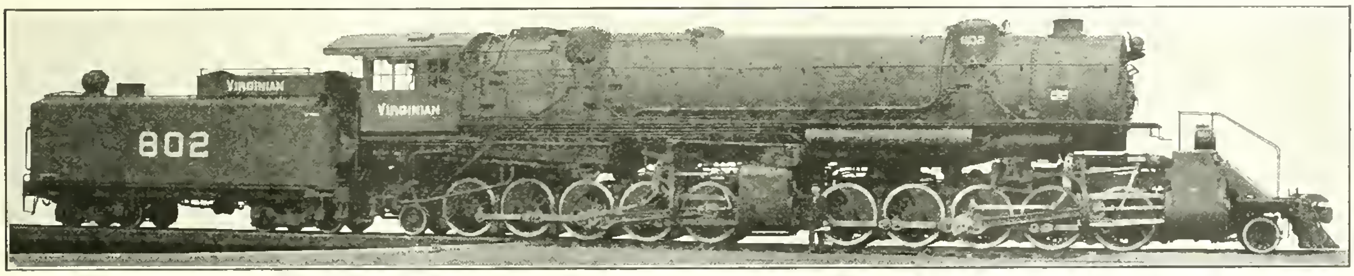
A steam power station with an installed generator capacity of 50,000 kw. will be built at a convenient location on the New River near the middle of the section to be electrified. Single-phase current will be transmitted at 88,000 volts over twin circuits on steel towers. The voltage will be reduced by means of transformers located at intervals along the right of way to 11,000 volts for the use on the trolley. The trolley system will be of the inclined catenary type utilizing a bronze contact wire and steel messengers all supported on steel poles and structures. No substations with revolving machinery are required for the system adopted for the reason that the locomotives utilize the same kind of current as is generated in the power station, i.e., alternating current single-phase. The power is fed to the trolley by simple outdoor type transformer stations.

The selection of the alternating-current single-phase system at this time after the successful operation with the same system on the Norfolk & Western, and the New York, New Haven & Hartford, and the Pennsylvania Railroads is significant as indication of its adoption as standard for the heaviest traffic operation on American railroads.

Railway and Locomotive Engineering is very glad to announce that the Virginian Railway Company have selected Mr. Hugh Pattison as engineer of electrical traction, to take complete charge of and handle this most important piece of railway electrification, which will no doubt be handled in a manner satisfactory both to the railway company and the Westinghouse Electric & Manufacturing Company, who are the contractors.

Mr. Pattison is exceptionally well equipped to handle this most important work, for he has had an exceptionally wide range of practical experience which, with his technical training and being tempermentally well suited, gives him a decided advantage over many who are less qualified.

Mr. Pattison was associated with the late Horace G. Burt, handling the electrical department in connection with the very exhaustive study and reports on electrification of terminal and smoke abatement in the city of Chicago. Following this he was one of the electrification commission employed by the Illinois Central to make a study and report on the electrification of their terminal properties, and in this capacity made a trip abroad studying the various electrical installations both in England and on the continent. With such splendid qualifications, Railway and Locomotive Engineering feels safe in saying that when Mr. Pattison puts the seal of approval on the Virginian job, it will be alright.—Snomys.



The Type of Mallet Locomotive, Weighing Approximately 450 Tons, Now in Service on the Virginian

Conference on Waste in Transportation

The Department of Commerce has issued a call for a conference of carriers, shippers and others interested in the problem of reducing waste in transportation. The preliminary hearing will be held in Washington on June 13. The announcement says:

"The American Railway Association is working to reduce waste in freight transportation. The Car Service Division is promoting heavier loading cars. A constructive movement to even out the distribution of commodities, to increase available storage capacity and to effect the means of moving as large a tonnage as possible before the seasonal crop movement commences has been instituted. The freight container bureau is promoting improved packing methods and more durable types of packing cases. The Department of Commerce is deeply interested in all activities leading to the elimination of waste, together with a more stable and even distribution of commodities and the subsequent conservation of capital, material, labor and time. The department offers the services of its division of simplified practice as a centralizing agency in bringing together all elements interested in such problems.

"This conference is called at the request of the two branches of the A. R. A. mentioned for the purpose of presenting to shippers the A. R. A. recommendations and to promote most effectively the greatest transportation efficiency and results. It is hoped that out of this conference will come a definite plan of co-operative action which the Department of Commerce can endorse and support and which will result in a nation-wide support of a constructive economic program in co-operation with the American Railway Association, its regional advisory boards of shippers and trade organizations."

Stresses in Car Wheels

Calculations Based on the Reports of the Bureau of Standards and the University of Illinois

By GEO. L. FOWLER

Within the past year RAILWAY AND LOCOMOTIVE ENGINEERING has published abstracts of four notable papers on the stresses and strains set up in car wheels by the application of brakes and of a resistance coil placed about the tread. Papers that for the value of the data contained rank among the first in importance in car wheel literature.

The first one, which appeared in the June, 1922, issue,

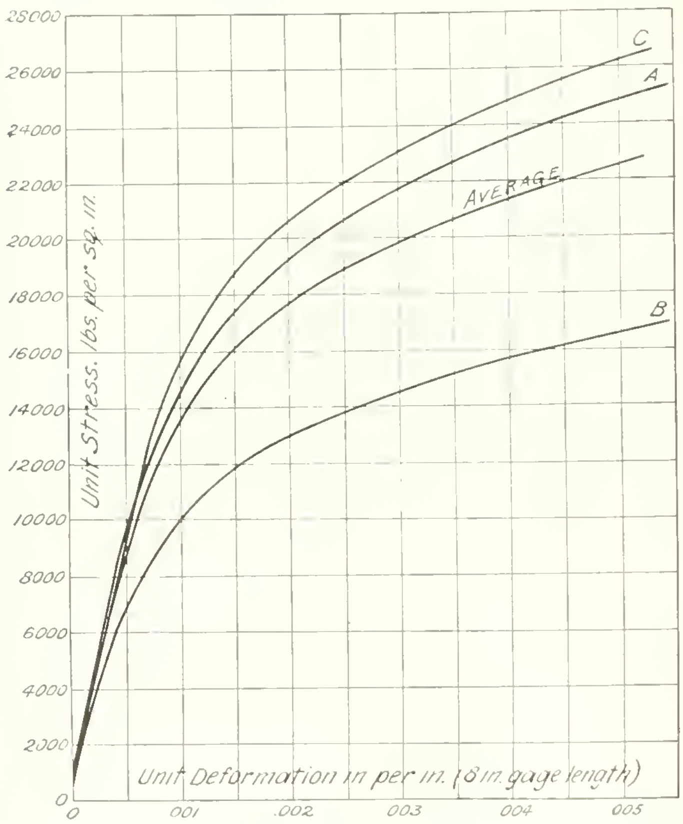


Fig. 1. Stress Strain Curves Obtained by the Bureau of Standards from Tensile Test on Samples of Cast Iron from Wheels of Three Manufacturers

was a bulletin of the Bureau of Standards and the other four were bulletins issued by the University of Illinois, and all were the result of an investigation instituted by the Association of Manufacturers of Chilled Car Wheels. In the bulletin of the Bureau of Standards a diagram was published showing the composite stress-strain curves obtained from a tensile test on samples of cast iron from wheels of three manufacturers which were marked A, B and C, respectively. This diagram was published on page 158 of the June, 1922, issue. For present purposes a fourth line has been added to the original diagram as reproduced in Fig. 1, showing the average stress-strain line of the three samples of car wheels originally shown, and in what follows it is assumed that this line fairly represents the character of the metal of car wheels as they are put upon the market.

It is evident that, as the stress and the strain are changed, there is no corresponding change in the ratios between them, in other words the modulus of elasticity changes also.

In the first bulletin issued by the University of Illinois, there was a table published (page 19) which was not reproduced in this paper, in which the modulus of elasticity was given for a constant tensile stress of 5,000 lbs. per sq. in. This shows a range of from 14,000,000 to 25,000,000. In the light of the Bureau of Standards diagram (Fig. 1) it is evident that these moduli could not be used for a calculation of the stresses set up in a wheel when the strains varied from .002 in. to .004 in. per inch of length.

It is because most engineers think in terms of stress instead of strain that this attempt has been made to tie the strains in car wheels as determined by the University

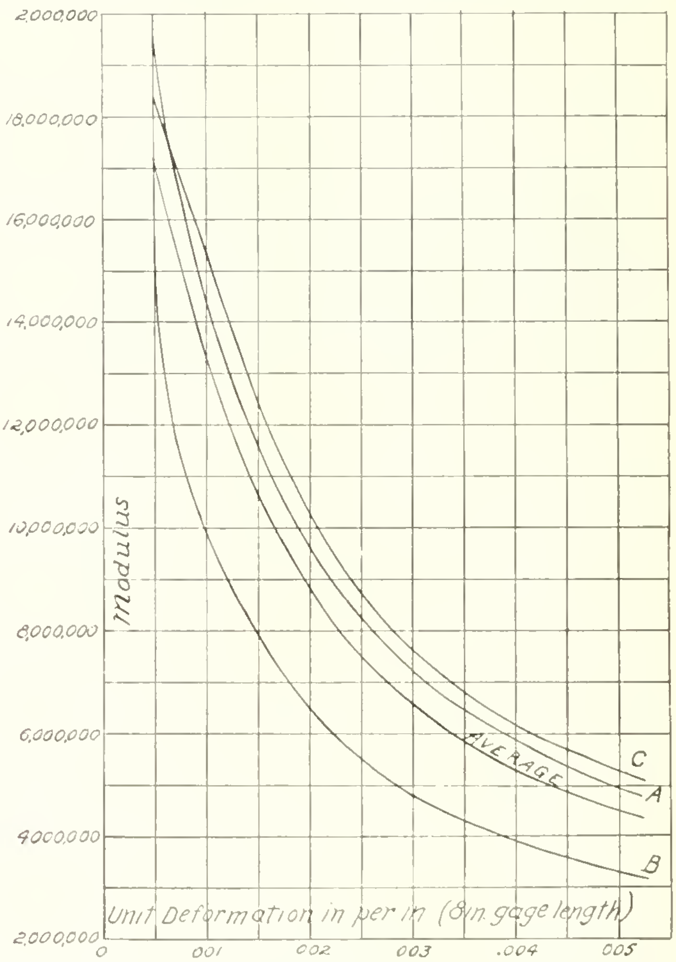


Fig. 2. Diagram of Moduli of Elasticity Developed from the Stress-Strain Diagram (Fig. 1), Using the Stress as a Base

of Illinois to the stress-strain diagram of the Bureau of Standards and so express the strains in terms of stress.

It cannot, of course, be maintained that the figures obtained will be an accurate expression of the actual stresses set up in the wheels by the braking tests at the University of Illinois, because of the variation in the physical properties of car wheels, and it is hardly probable that any one of the wheels tested at the university would have had the exact properties as represented by the average of the three tested at the Bureau of Standards. But had such an average wheel been tested, and the results shown been obtained therefrom, the stresss set up would have been those indicated.

In order to show the variation in the modulus of elasticity of the three wheels as indicated by the stress-strain diagram (Fig. 1) of the Bureau of Standards, a second diagram (Fig. 2) has been prepared showing the modulus of elasticity of the three car wheels. This diagram was developed by first making a photographic enlargement of the original, and then dividing the space between the thousandth marks by ten and reading the corresponding stresses. A division of the stress by the corresponding strain at each of these points, gave the various moduli as shown in the special table and from these, the diagram (Fig. 2) was plotted.

Brake shoe Pressure lb.	Speed per hr. mi.	Distance mi.	Coefficient of Friction Mean	Temperature Difference Between Couples Nos. 1 & 6 Deg. F	Unit Deformations at Stopping in. per in.: Maximum Tensile Strain	Unit Deformations at Stopping in. per in.: At Gage-line	Maximum Tensile Stress lbs. per sq. in.: Average Wheel	Maximum Tensile Stress lbs. per sq. in.: Wheel C
Test on 33 in.—650 lb. Arch Plate Wheel								
Wheel Slightly Eccentric								
2,019	9.98	19.95	0.34	332	0.0021	04R	17,866	20,850
2,023	19.96	19.96	0.26	469	0.0027	04R	19,116	22,250
2,022	30.06	15.03	0.20	284	0.0021	04R	17,866	20,850
Wheel Ground True								
2,019	9.98	19.96	0.39	375	0.0022	04R	18,083	21,100
2,015	19.93	19.93	0.27	437	0.0027	04R	19,116	22,250
2,016	29.84	14.92	0.23	595	0.0034	04R	20,383	23,750
2,014	39.88	9.97	0.21	375	0.0023	04R	18,300	21,350
2,015	49.75	9.95	0.21	474	0.0023	04R	18,300	21,350
Tests on 33 in.—725 lb. M. C. B. Wheel								
2,005	10.01	20.02	0.35	340	0.0031	05R	19,850	23,050
2,003	19.95	19.95	0.26	427	0.0039	05R	21,083	24,500
2,002	30.00	15.00	0.21	485	0.0034	05R	20,383	23,750
1,999	39.92	9.98	0.21	327	0.0029	05R	19,483	22,650
2,002	49.75	9.95	0.19	444	0.0029	05R	19,483	22,650
Tests on 33 in.—750 lb. M. C. B. Wheel								
2,012	10.02	20.04	0.34	351	0.0020	05R	17,616	20,600
2,006	19.98	19.98	0.26	395	0.0027	06R	19,116	22,250
2,006	30.00	15.00	0.24	455	0.0027	04R	19,116	22,250
2,005	39.92	9.98	0.20	443	0.0023	04R	18,300	21,350
1,998	49.84	9.97	0.21	340	0.0025	04R	18,733	21,850
Tests on 33 in.—750 lb. Arch Plate Wheel								
2,022	10.01	20.02	0.32	317	0.0021	06R	17,866	20,850
2,011	19.99	19.99	0.23	382	0.0027	06R	19,116	22,250
2,002	29.82	14.91	0.18	461	0.0021	06R	17,866	20,850
1,999	39.96	9.99	0.17	352	0.0022	06R	18,083	21,100
2,011	50.00	10.00	0.17	417	0.0023	06R	18,300	21,350
2,016	29.54	14.77	0.16	515	0.0028	06R	19,300	22,450
2,442	30.04	15.02	0.19	540	0.0029	06R	19,483	22,650
2,600	39.76	9.94	0.18	462	0.0030	06R	19,666	22,850
2,352	48.50	9.70	0.17	603	0.0028	06R / 05R	19,300	22,450
2,359	49.30	9.86	0.17	360	0.0030	06R	19,666	22,850
2,358	49.75	9.95	0.16	542	0.0025	05R	18,733	21,850
Tests on 33 in. 950 lb Arch Plate Wheel								
1,001	10.00	19.99	0.39	138	0.0007	02R	10,785	12,320
1,004	10.03	10.03	0.39	152	0.0010	03R	13,300	15,600
983	19.98	19.98	0.27	242	0.0006	03R	10,193	10,760
1,004	20.09	30.14	0.31	350	0.0003	04R	5,160	5,520
1,015	20.22	10.11	0.35	200	0.0008	03R	12,726	13,600
1,012	30.33	20.22	0.36	265	0.0014	02R	15,566	18,200
1,002	30.09	10.03	0.29	215	0.0010	03R	13,300	15,600
1,011	40.16	20.08	0.23	321	0.0011	02R	14,050	16,450
1,006	49.18	19.67	0.26	298	0.0016	03R	16,350	19,100
1,006	49.20	19.68	0.25	338	0.0015	03R	15,966	18,650
1,004	49.25	9.85	0.21	255	0.0013	03R	15,133	17,700
2,025	9.98	19.97	0.36	267	0.0014	02R	15,566	18,200
2,018	9.98	9.98	0.35	250	0.0024	03R	18,516	20,600
2,022	19.99	19.99	0.28	344	0.0021	03R	17,866	20,850
2,016	20.06	10.03	0.29	318	0.0018	03R	17,050	19,950
2,017	20.07	30.11	0.29	350	0.0023	03R	18,300	21,350
2,023	30.21	20.14	0.20	385	0.0018	03R	17,050	19,950
2,013	30.30	10.10	0.24	373	0.0016	03R	16,350	19,100
2,018	40.28	20.14	0.21	457	0.0029	03R	19,483	22,650
2.018	49.75	19.90	0.18	462	0.0025	03R	18,733	21,850
2.020	47.65	9.53	0.23	380	0.0021	03R	17,866	20,850
3.009	10.04	20.08	0.36	373	0.0024	03R	18.516	21,600
3,021	10.02	10.02	0.34	334	0.0020	03R	17,616	20,600
3,003	20.02	20.02	0.27	448	0.0029	03R	19,483	22,650
3,010	20.20	10.10	0.26	383	0.0020	03R	17,616	20,600
3,005	30.16	20.11	0.20	555	0.0034	03R	20,383	23,750
3,012	40.20	20.10	0.18	540	0.0033	03R	20,216	23,550
3,015	49.48	19.79	0.17	473	0.0037	03R	20.816	24,200
Tests on 33 in.—786 lb. Forged Steel Wheel								
2,008	9.90	19.81	0.29	335	0.0036	03R	100,800*	
2,011	19.83	19.83	0.21	411	0.0044	03R	123,200*	
2,009	29.78	14.89	0.20	410	0.0042	03R	117,600*	
2,003	39.64	9.91	0.19	393	0.0035	03R	98,000*	
1,999	49.75	9.95	0.20	341	0.0040	03R	112,000*	

*Calculated on the basis of modulus of elasticity = 28,000,000

Summary of Principal Results of Continuous Brake Application in Stresses and Strains

The characteristic feature of this diagram is the rapid drop in the value of the moduli in the lower ranges of unit deformations, demonstrating the point already stated that the moduli given in the table of the first bulletin issued, in connection with these tests, by the university, would be misleading were an attempt be made to apply it to the determination of stresses set up by the braking tests.

A third diagram (Fig. 3) showing similar characteristics to those of Fig. 2, has been prepared, using the unit stress in pounds per sq. in. as a base. This, however, owing to the greater difficulties of measurement, probably shows too high a modulus for the low unit stresses.

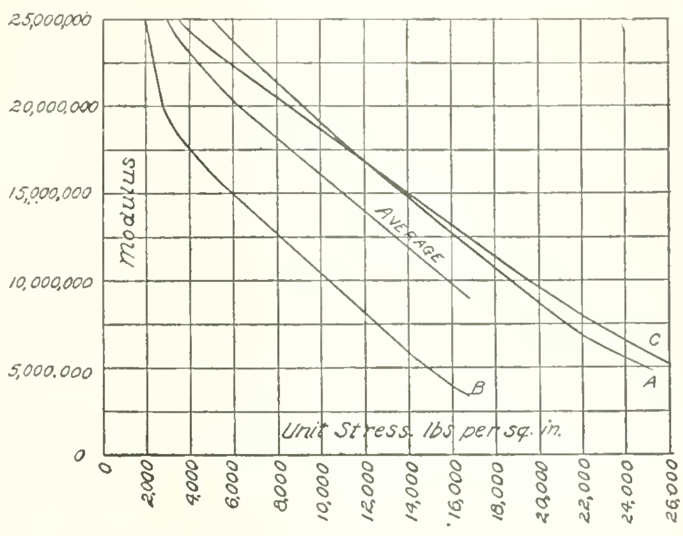


Fig. 3. Diagram of Moduli of Elasticity Developed from the Stress-Strain Diagram (Fig. 1), Using the Stresses as a Base

Strain in inch per inch of length	Wheel A	Wheel B	Wheel C	Average
.0005	19,600,000	15,600,000	18,400,000	17,200,000
.00075	16,533,333	11,333,333	17,466,666	15,111,111
.0010	14,400,000	9,900,000	15,600,000	13,300,000
.0011	13,909,909	9,454,545	14,954,545	12,772,727
.0012	13,250,000	9,041,666	14,250,000	12,180,000
.0013	12,615,362	8,692,308	13,615,362	11,640,769
.0014	12,071,429	8,285,714	13,000,000	11,118,571
.0015	11,633,333	7,933,333	12,433,333	10,644,400
.0016	11,125,000	7,593,750	11,937,500	10,218,750
.0017	10,705,882	7,294,117	11,500,000	9,832,941
.0018	10,333,333	7,000,000	11,083,333	9,472,222
.0019	9,973,684	6,756,842	10,684,211	9,131,526
.0020	9,625,000	6,500,000	10,300,000	8,808,000
.0021	9,309,524	6,285,714	9,938,571	8,507,619
.0022	9,000,000	6,068,181	9,590,909	8,219,545
.0023	8,717,391	5,869,565	9,282,609	7,956,522
.0024	8,458,333	5,687,500	9,000,000	7,715,000
.0025	8,220,000	5,520,000	8,740,000	7,493,200
.0026	8,000,000	5,365,385	8,480,769	7,266,538
.0027	7,777,777	5,222,222	8,240,741	7,080,000
.0028	7,571,428	5,089,285	8,017,857	6,964,286
.0029	7,379,310	4,965,517	7,810,345	6,718,276
.0030	7,200,000	4,850,000	7,616,666	6,555,333
.0031	7,032,258	4,741,935	7,435,484	6,403,226
.0032	6,865,000	4,625,000	7,296,875	6,265,628
.0033	6,727,272	4,515,152	7,136,364	6,126,061
.0034	6,588,235	4,411,765	6,985,294	5,980,294
.0035	6,457,143	4,314,286	6,828,571	5,866,571
.0036	6,333,333	4,222,222	6,680,555	5,745,278
.0037	6,202,703	4,135,135	6,540,541	5,625,946
.0038	6,078,947	4,052,632	6,407,895	5,513,158
.0039	5,961,538	3,974,357	6,282,052	5,405,897
.0040	5,850,000	3,900,000	6,162,500	5,304,000
.00425	5,600,000	3,741,176	5,905,883	5,082,353
.0045	5,355,555	3,577,777	5,655,555	4,862,889
.00475	5,136,842	3,431,579	5,410,591	4,666,526
.0050	4,940,000	3,300,000	5,220,000	4,486,600
.00525	4,761,905	3,180,952	5,028,571	4,323,429

Moduli of Elasticity of Car Wheel Iron Calculated from the Bureau of Standards Stress-Strain Diagram (Fig. 1)

On the basis of the moduli determined for the three wheels from the stress-strain diagram (Fig. 1) we find that they varied as follows for—

Wheel A from 19,600,000 to 4,760,000.
Wheel B from 15,600,000 to 3,180,000.
Wheel C from 18,400,000 to 5,000,000.
Average from 17,800,000 to 4,320,000.

under strains that ran from .0005 in. to .00525 in. If the

Strain in inch per inch	WHEEL A	B	C	Average
.0005	9,800	6,800	9,200	8,600
.00075	12,400	8,500	13,100	11,333
.0010	14,000	9,900	15,600	13,300
.0011	15,300	10,400	16,450	14,050
.0012	15,900	10,850	17,100	14,616
.0013	16,400	11,300	17,700	15,133
.0014	16,900	11,600	18,200	15,566
.0015	17,350	11,900	18,650	15,966
.0016	17,800	12,150	19,100	16,350
.0017	18,200	12,400	19,550	16,716
.0018	18,600	12,600	19,950	17,050
.0019	18,950	12,800	20,300	17,350
.0020	19,250	13,000	20,600	17,616
.0021	19,550	13,200	20,850	17,866
.0022	19,800	13,350	21,100	18,083
.0023	20,050	13,500	21,350	18,300
.0024	20,300	13,650	21,600	18,516
.0025	20,550	13,800	21,850	18,733
.0026	20,800	13,950	22,050	18,933
.0027	21,000	14,100	22,250	19,116
.0028	21,200	14,250	22,450	19,300
.0029	21,400	14,400	22,650	19,483
.0030	21,600	14,550	22,850	19,666
.0031	21,800	14,700	23,050	19,850
.0032	22,000	14,800	23,350	20,050
.0033	22,200	14,900	23,550	20,216
.0034	22,400	15,000	23,750	20,383
.0035	22,600	15,100	23,900	20,533
.0036	22,800	15,200	24,050	20,683
.0037	22,950	15,300	24,200	20,816
.0038	23,100	15,400	24,350	20,950
.0039	23,250	15,500	24,500	21,083
.0040	23,400	15,600	24,650	21,216
.00425	23,800	15,900	25,100	21,600
.0045	24,100	16,100	25,450	21,883
.00475	24,400	16;300	25,800	22,166
.005	24,700	16,500	26,100	22,433
.00525	25,000	16,700	26,400	22,700

Tensile Stresses in Car Wheel Iron Calculated from the Bureau of Standards Stress-Strain Diagram (Fig. 1)

moduli as thus obtained are used for the calculation of the stresses developed in the wheels by the braking tests, as set forth in the table taken from bulletin No. 135 of the University of Illinois and published on page 159 of the May issue of Railway and Locomotive Engineering, the accompanying table showing those stresses is obtained. On the basis that the wheel used in the braking tests was an average of the three wheels used by the Bureau of Standards, the stresses shown in the column headed "Average" are obtained. These vary from 5,160 lbs. per sq. in. after a run of a little more than 30 miles at a speed of about 20 miles per hour under a brakeshoe pressure of 1,004 lbs. to 21,083 lbs. for a run of a little less than 20 miles at a speed of a little less than 20 miles an hour under a brakeshoe pressure of 2,003 lbs. But, if the wheel were considered to have been similar to the C wheel of the Bureau of Standards, these stresses would have been jumped to 5,520 lbs. and 24,500 lbs. respectively. In other words, a doubling of the brakeshoe pressure even though the distance run were reduced by one-third increased the stresses between four and five fold.

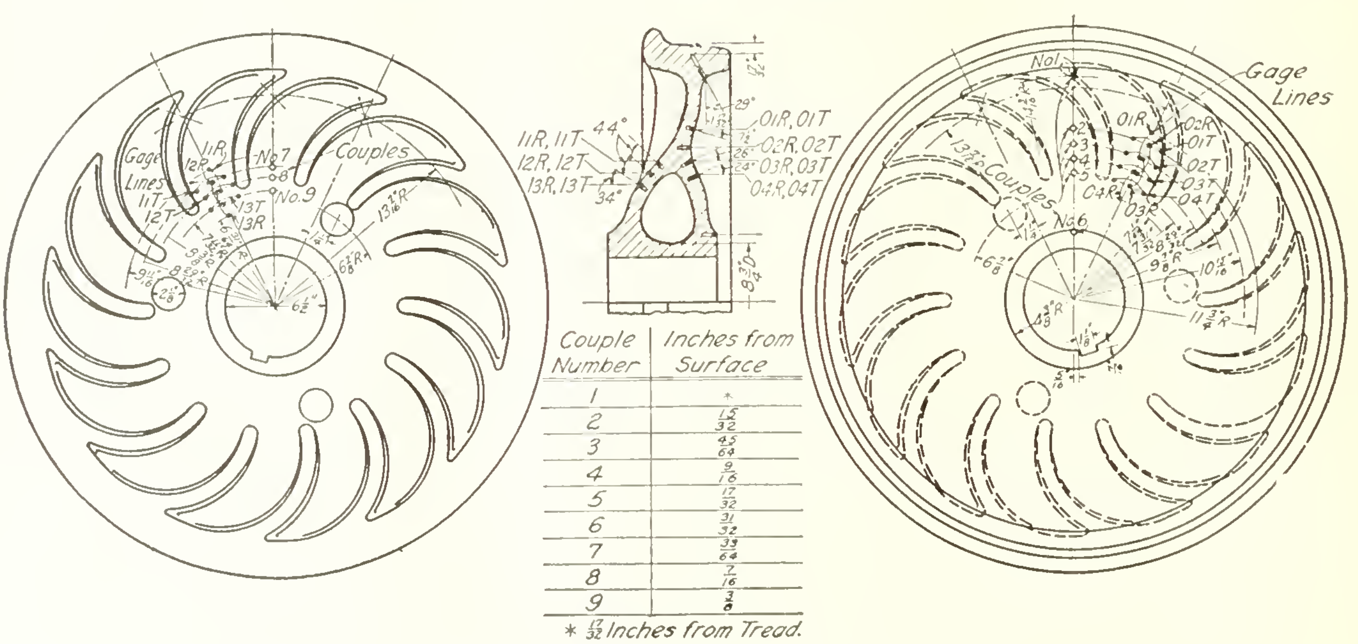
That there are many vagaries in the results is to be expected, and some of them are quite inexplicable from the data available. For example, take the last three tests of the 33 in. 750 lb. arch plate wheel. Here we have three tests conducted under practically the same conditions of speed, distance, brakeshoe pressure and coefficient of friction, and yet we have temperature variations of from 306° to 603° Fahr., strains ranging from 0.0025 to 0.0030 in. and strangest of all the highest strain with the lowest temperature variation. There is, of course, some very good reason for these apparent paradoxes, and it is suggested that there is a possibility that they may be due to initial casting strains that may have existed in the metal, and which manifested themselves in this strange way under the existing temperature conditions.

This item of the internal stresses in car wheels as the result of casting strains may be of considerable importance and the value may be high. This is a matter that was not taken into consideration by either of the series of tests which we have had under consideration, and data on the subject is very meagre.

A number of years ago a rather crude investigation was made looking to the determination of this matter, the results of which, while probably only approximately accurate are nevertheless indicative of probable conditions.

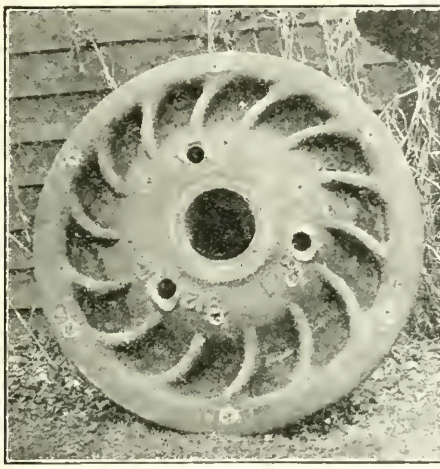
Two wheels were experimented upon, and the method of making the determination was as follows:

Each wheel had six spots laid out on it at approximately equal distances apart on the rim and the plate, as shown in the engraving. These markings were carefully



Location of Gauge Lines and Thermocouples, 33 inch, 625 lb. Wheel drilled with countersunk holes that were truly parallel to each other, and the distances between each two were accurately measured with a Howard strain gauge, especially constructed for the purpose by the Brown & Sharp Manufacturing Co. Before taking these measurements the gauge and the wheel were exposed to the same constant temperature for 24 hours. After the measurements had been taken, the centres and hubs were cut out as shown in the engraving, and the measurements between each two points of the rim were again taken.

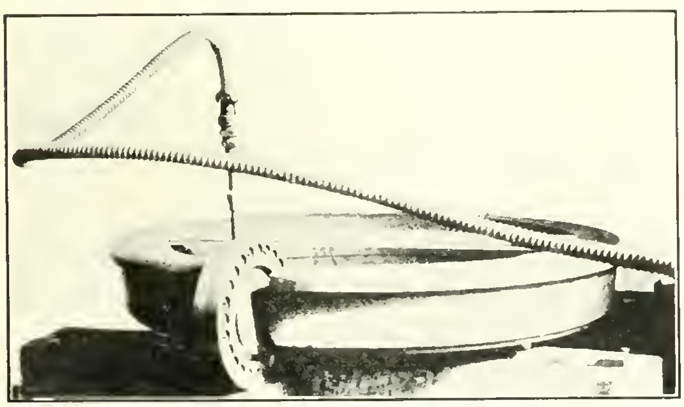
The rim was then severed by cutting away on each side until only a thin strut was left which was broken by the internal compression stress existing in the metal. This is shown, after rupture, by the engraving. Again the distances between each two points were taken, and, after the broken strut had been cut away the amount of pressure was measured, that was required to push the rim apart to its original dimensions across the gap made by the cutting. This was done by an especially constructed dynamometer, which is shown in place in the engraving.



Cast Iron Wheel Showing Markings For Strain Measurements

Cast Iron Wheel Showing Center and Hub Removed

Rim of Cast Iron Wheel After Breakage of Strut By the Compression Stress



Dynamometer in Place for Forcing Wheel Rim Back to the Dimensions Existing After the Removal of Center and Hub

The measurements between the several points showed a progressive increase in the circumferential dimensions of the rim with corresponding diametral distortions. The springing together of the gap of the two ends of the rim after cutting the gap was .1119 in. and .1380 in. respectively.

Taking into consideration the pressure required to open the gaps to their original dimensions with the sectional area of the rim, it amounted to 1,493 lbs. and 1,107 lbs. per square inch, for the two wheels respectively.

In this work nothing was done to determine radial strains after the manner of the work done at the University of Illinois; but the fact remains that it is hardly probable that these tangential stresses could have existed without some existing in a radial direction also. As to how much influence these may have had on the strains as measured is a matter for future determination.

But taking the stresses and strains at their face value we find that they are running very close to the breaking strength of the metal. For, according to the tests made at the University of Illinois, this strength, in samples cut from the wheels, ranges from 20,800 lbs. to 31,800 lbs. per sq. in. Evidently then if the stresses corresponding to those that would have been developed in the C wheel of the Bureau of Standards under a strain of 0.0039 in. (24,500 lbs. per sq. in.) had been developed in a wheel whose metal had a tensile strength of but 20,800 lbs. per sq. in., a crack would have resulted. In short, the stresses apparently developed were well up in the danger zone of breaking in ordinary wheels. And it will be remembered that the wheels tested were ordinary wheels that were taken at random from stock.

There is still another analysis possible in connection with these investigations and that is the adaptation of the laboratory tests to operating conditions, and this will be done in a future article.

Fewest Bad Order Locomotives on Record

The railroads of the United States had more serviceable locomotives on their lines on May 1 this year than at any time since August 1, 1920, which is as far back as the records of the American Railway Association go. At the same time the railroads had fewer locomotives in need of repair than ever before on record.

Serviceable locomotives on May 1 totaled 50,259. This was an increase of 152 over the total number on April 1 this year, when the previous record was established.

Locomotives in need of repair on May 1 totaled 14,131, or 22 per cent of the total on line. This was a decrease of 719 since April 15, at which time the total was 14,850, or 23 per cent.

Of the total number, 12,473 locomotives were in need of repairs requiring more than 24 hours. This number represented 19.4 per cent of the number on line. Under the program agreed upon by the railroads last month in New York, the number of locomotives waiting such repairs is to be reduced to 15 per cent by October 1 next. The number in need of heavy repair on May 1 was a decrease of 699, compared with that on April 15.

Reports also showed 1,658 locomotives, or 2.6 per cent, of the total number on line, to be in need of light repairs on May 1. This was a decrease of 20 since April 15.

Steel-Car Construction at the Angus Shops of the Canadian Pacific Railway, Montreal*

By H. R. NAYLOR, Assistant Works Manager, Angus Car Shops, Canadian Pacific Railway

Despite the great advances that have been made in locomotives, train control and terminal facilities, it is a question whether the relative advance in any one of them has equaled that in car construction. To particularize, a comparison of the modern 60-ton steel frame box car with the 30-ton wood frame car commonly built fifteen years ago, brings out two points: the complete change in design and the effect that this change in design has had on the car shops.

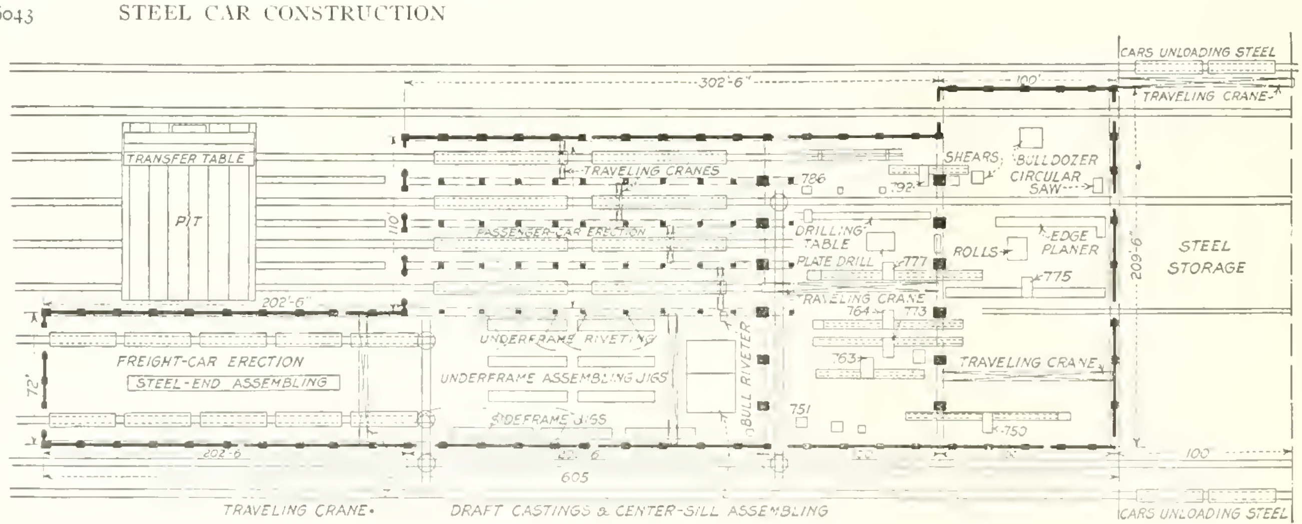
It is obvious that the facilities for building the wood-frame car would be quite inadequate for the steel car, and the present paper deals with this phase of steel car construction as it has been met by the practice of the Canadian Pacific Railway. The wood-frame car was gradually replaced until, in 1909, the Canadian Pacific Railway originated a box car having an entire frame built of steel. Then, within a period of six years (1909-1914) this road added 30,841 steel-frame box cars to its equipment and later the United States Railroad Administration included 50,000 cars of this type in a single order.

The earlier type of steel-frame box car, shown in Fig. 1, was built with center sills of 15 in. channels, side sills of 8 in. channels, side and end posts of 4 in. Z-bars, and corner posts of 5 in. angles. The longitudinal sheathing was bolted to the inside of the framing, in which elongated holes were punched to allow the boards to be retightened without removing the bolts. This feature, however, has since been discontinued, as there is a possibility of the joints between the boards reopening if they are not effectively checked.

The Angus shops were already well equipped for building passenger and freight cars on an extensive scale, having a capacity of 40 freight cars per day. This remarkable organization was, however, rendered obsolete to a large extent by the introduction of the steel-frame box car and the erection of an additional shop became a necessity. This shop was designed for building the steelwork of both passenger and freight equipment, and embodied in its arrangement many novel features for the rapid handling of material to and from the machines, and also during the various stages of assembly. At the time of its erection it probably represented the best practice on this continent, being a combination of the good features observed in other shops with the original ideas developed at the time the layout was being planned.

The freight section of the shop was designed to construct steel-frame box cars in the most economical manner, and although some minor modifications have been made in the machinery layout and erecting equipment to meet subsequent developments, the shop has well served the purpose for which it was intended and has furthermore proved equally satisfactory for building large orders of automobile, refrigerator, coal, and flat cars, in addition to steel snow plows and other snow-fighting equipment. At intervals between new car construction the shop is used extensively for repairing and rebuilding steel freight and passenger cars.

6043 STEEL CAR CONSTRUCTION



Plan of Steel-Car Shop, Canadian Pacific Railway, Angus Shops, Montreal

Description of the Shop

The new shop was located adjoining the wood-freight-car shop, facing a midway upon either side of which were also located the supplementary shops, the midway being served with overhead traveling cranes. It is a steel-frame structure, with steel columns carried on concrete piers, the lower foundation walls being of concrete, 24 in. thick to the ground level and 20 in. thick to a height of 2¾ ft., above which the walls are of red brick and 16 in. thick. The sash frames are of steel, the total sash area being approximately 40 per cent of the total wall space. The roof is carried on steel trusses with ample skylight area. The floors are of 4-in. concrete with a top surface of ⅝ in. mastic.

There are three main divisions to the shop. The front one, facing the midway and occupying the entire front, is the machine section, consisting of two 100-ft. bays running parallel to the midway, the one adjoining the midway being 209½ ft. long, while the inner bay is 182 ft. long. Each bay is served by a 10-ton electrically operated crane of the open-latticework type having a span of 96¼ ft., and a height to base of rail of 28½ ft.

*Paper presented at the spring meeting of the American Society of Mechanical Engineers, Montreal, Canada, May 28-31, 1923.

The freight-car erecting section is situated in the rear of the machine section, is 72 ft. wide and 405 ft. long, and was originally equipped with one 10-ton traveling crane having a span of 67½ ft., and a height to base of rail of 27 ft. An addition crane of similar capacity has since been installed in this section.

Situated also to the rear of the machine shop is the passenger-car erecting section, consisting of four bays having a total width of 110 ft. These four bays with the 72-ft. freight-car bay complete the full width of the back of the machine shop. Each bay of the passenger-car section is provided with a separate 2-ton traveling crane having a span of 24 ft. 10 in. and a height to base of crane rail of 21 ft.

Along the entire front of the shop, between it and the midway, there is ample provision for storing material. This storage yard is 100 ft. wide and is served by a 10-ton crane whose span and height are identical with those in the machine section in anticipation of future shop extension. This crane runway extends beyond the shop limits and spans several tracks where cars of material can be readily switched and unloaded.

Through the freight-car erecting shop, entering from the rear end, are two standard-gage tracks 18 ft. center to center which extend the full length but do not enter the machine shop. Outside the shop and parallel to the south wall a standard-gage track connects with a track on the midway through turntables. This track is used for delivering the car trucks from the truck shop to the final assembly tracks.

Through each of the passenger-car erecting bays there is a standard-gage track leading in from the rear of the shop, also a transfer table for moving the cars during the various stages of completion. Through the center of the material storage yard, there is a standard-gage track connecting by turntables with three tracks running into the machine shop.

Crane Facilities

The crane facilities are unique in that the whole area of the shop is traversed by electrically operated traveling cranes so arranged that it is possible to install an unusual number, and yet maintain for each crane complete freedom of operation at all times. In this instance the crane arrangement was the deciding factor in the shop layout. It was decided that the machine section of the shop would be independent of the erecting sections in so far as crane service was concerned, and for this reason the crane runways in this section were installed in a direction transverse to those in the erecting shop. This arrangement made it possible to equip the two machine bays with separate cranes, each having a wide range of action with no interference.

The machine layout is arranged with the view of relieving the overhead cranes to the greatest possible extent. This applies particularly to the handling of the larger members, such as center and side sills which are required to pass over two punching machines situated in the different bays. As the first operation is completed the sills are transferred to the second machine by special devices independently of the overhead cranes. On completion of the machining operations the sills are then skidded over to the assembling trestles in the erecting shop without assistance from the overhead cranes.

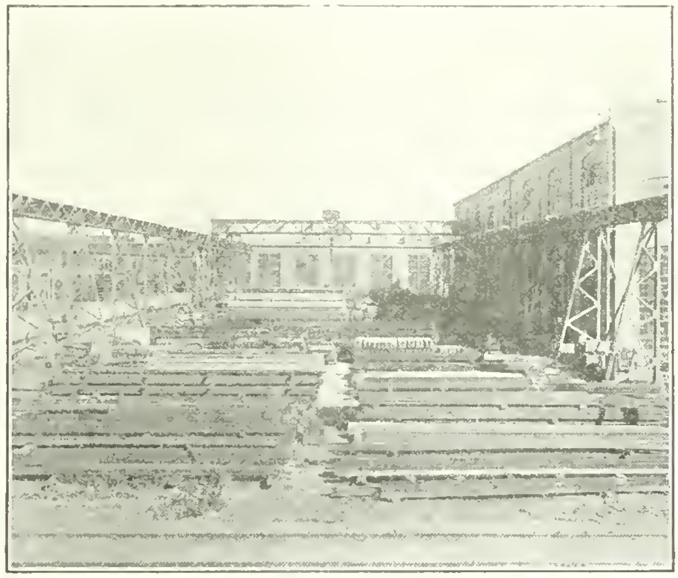
The two cranes in the freight-car erecting shop, operating on the same runway, are entirely free from machine-shop handling, and as the first one is assigned to the preliminary assembly positions and the second to the final assembly positions, there is no overlapping or interference. The crane facilities in the machine and freight-car erecting shops will be better appreciated if one will endeavor to imagine four cranes on a single runway attempting to handle an equivalent amount of work.

The Machine Equipment

The machine shop is equipped with the following machinery: Four automatic spacing punches, five coping punches, five high-speed punches, two horizontal punches, one 7-ft. 6-in. gate shear, one angle shear, one 36-ft. plate-edge planer, one 30-in. circular saw, one 30-in. metal band saw, one 7-ft. plate roll, one 10-ft. brake, one bulldozer, two special plate-drilling machines, and miscellaneous drill presses, all driven by independent motors.

The arrangement of the machines is such that the material after each operation moves forward in the direction of the erecting shops, backward movement being carefully avoided, thereby reducing material handling to a minimum.

The high-speed punches are belt-driven direct from motor to flywheel, gears being dispensed with. Clutches are of the 6-point type. The heads are equipped with two punches which are controlled by gag levers. These machines are well adapted for punching the smaller plates for which metal templets are made up and into which holes are drilled; by inserting a pin or gage in each successive hole and butting the plate against the pin, the desired spacing is obtained. In certain classes of work the operator can move the material fast enough to catch every hole with the punch running at the rate of 60 strokes per minute.



Storage Yard Along Front of Steel-Car Shop

An unusual plan was followed as regards the installation of machines for heavy punching. The usual practice had been to install a small number of high-capacity machines for the punching and slotting of the sills, side plates, and similar members, necessitating frequent changing of dies and templets, with further limitations in the event of breakdowns. It was therefore decided to overcome these handicaps by installing four automatic spacing punches of moderate capacity to obviate the expense and delay of die changing and double handling, and as the five additional coping punches are duplicates of those used in the automatic spacing tables, replacement can be made with but short delay should they become disabled.

The Machining Operations

The storage yard in front of the shop is used for storing the larger members such as sills, cover plates, side plates, etc.; the smaller parts such as the posts and braces, bolster and crossbearer diaphragms, etc., are made by bulldozers and hydraulic presses in the blacksmith shop.

The machines are served by narrow-gauge service tracks running from the material storage yard, special care being taken to unload the material close to the track by which it will enter the shop. The progress of material through the machine shop is as follows: Center sills and side-sill channels are loaded by overhead crane and brought into the shop on service lorries and deposited on trestles opposite the traveler at rear of center- and side-sill web spacing punch. Two air-operated traversing jacks lift the sills in pairs and place them on the traveler rollers ready to pass through the machine. On the far side of this punch is an elevated runway carrying the traveler head which grips the sills with its projecting jaws and automatically spaces the punching. Along the traveler runway steel templets with projecting pins engage a trip lever suspended on the head of the traveler, close the electric circuit, arrest the travel of the head, and close the circuit of the punch control; the punch then completes the operation. After passing through this machine the sills are released from the jaws of the traveler, lifted by jib cranes and deposited back to back on the rollers of sill-flange spacing punch, which are placed directly opposite the delivery end of the web punch. On completion of the first operation the sills are disengaged from the head clamp and pushed back over the rollers to the starting point, where they are again turned over by a special device attached to the jib cranes and passed through the machine for the second operation on the opposite flanges. The sills are then lifted by the traveling crane of the inner section of the machine shop and placed on the rollers of coping punch directly opposite, where draft-key and lever slots are punched, completing the operations on the sills.

The center-sill and body-bolster cover plates and similar plates are punched on spacing punch. The side plates are punched on automatic spacing punch in a similar manner to the sills, passing through for the first and second operations in pairs.

In all of these operations the passage through the machines is rapid and the accuracy of the spacing mechanism is such that the punching error is slight and far less than it would be were each hole marked off and punched independently.

There are certain parts which cannot be handled satisfactorily on the spacing punches, yet the punching must be equally as accurate or otherwise much of the benefit obtained from the spacing punches is lost when the parts are assembled. The machining of the ends of the side posts and braces is an example of this kind. In this case special combination dies are used to shear the ends to shape and punch the group of holes in one operation.

The bolster cover plates and diaphragms are machined in a similar manner, the cover plates being passed over the spacing punch and the diaphragm flanges punched in one of the coping punches equipped with special dies for punching the flange holes in one operation. During these operations the machine is relieved of excessive load by varying the length of the punches, resulting in the holes being punched consecutively.

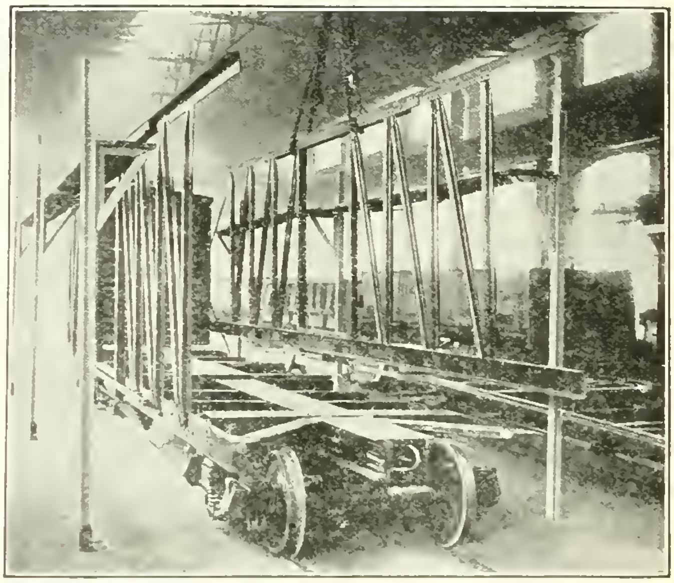
The usual practice for freight-car work is to punch rivet holes to a diameter not exceeding that of the rivet, and, when the parts are bolted together, to ream the holes to a size not exceeding that of the rivet by more than 1/16 in.

The Jig Method of Assembly

The erecting of steel-frame box cars by the jig method was originated at the Angus shops. By this method the underframe, side frames, and end frames are assembled on jigs as complete units ready for the final assembly of the car. The jigs consist of stands or cradles by means of which the various members are accurately placed and held in proper relation to each other until they are riveted together. The advantages of this method are manifold. As each member lies flat in the jig the drawing together of the parts is reduced to a minimum, wedge bolts being used extensively for this purpose as they can be rapidly applied. A complete unit being assembled in one operation, the possibility of a cumulative error is avoided. The jigs dispense entirely with checking for squareness, alignment, and location of connection holes, thereby simplifying the final assembly to a considerable extent.

Before any of the parts are assembled, all concealed surfaces are painted to prevent corrosion.

The center-sill channels after passing through slot-punching machine are skidded from the idle rollers to trestles just inside the erecting shop, where the draft castings are temporarily bolted on and the holes reamed ready for riveting. An electric hoist operating on a runway below and clear of the overhead cranes, swings the sills into position and the draft castings are riveted on by a compression riveter. The individual sills are then moved across to a position on the left where the two center sills are assembled and riveted with bolster center castings and separators in position. The sills are placed on stands on which are four fixed pins corresponding to four rivet holes in the sills at the center line of the bolsters. By placing the sills flange down on these pins perfect alignment of the two sills is assured, which simplifies the application of cover plates later on. The draft gear is also applied in this position.



Placing the Side Frames in Position

The next step is the assembling of the underframes, and as this is a lengthy operation, four positions are assigned for the purpose. These jigs consist of four steel cradles located at bolster and cross-bearer centers, and so arranged that each member of the underframe is held in proper alignment and at centers that will coincide exactly with connections on the side frames. The bottom cover plates of the bolster and cross-bearers are first placed on centering pins; the overhead crane then places the center sills in position, to which are attached the bolster and cross-bearer diaphragms with their cover plates and center-sill cover plate complete, after which the assembly is bolted together and the holes reamed ready for riveting.

The underframes are then swung over by the overhead crane to the riveting jigs on the right, which are constructed similar to those used for assembling, thereby maintaining the proper alignment. Each riveting position is equipped with two 50-ton compression riveters suspended from swinging jib cranes, the posts of which are in line with columns to the right. The crane jibs are 21 ft. in length with runways for air hoists, the suspension mechanism being so arranged that the riveters can be tilted to drive the rivets in the inclined bottom flanges of the bolster and cross-bearers which otherwise would have to be driven by an air hammer. The compression riveters were specially designed on the scissors principle, with a thin nose to permit of the top and bottom rows of rivets being driven without turning the underframe over in order to complete the operation.

The side frames, consisting of the side sill, side-plate, post, braces, door posts, and track, are assembled as a unit on a jig frame situated abreast of the underframe jigs. This jig consists of channel-iron stands, the four corner ones of which are capped with short sections of channel iron in which are holes for locating exactly the side sills and plates. The stands on either side are tied together with angle bars which carry additional cross-bars upon which the various members of the side frames are placed in proper relation to each other. In this position the side frame is temporarily bolted, reamed, and riveted ready for the final assembly position.

Originally the end frames were assembled on jigs similar to those used for the side frames, but in recent years the end-post construction has been replaced by corrugated-steel ends. These steel ends and the end sills are assembled on trestles located between the final assembling tracks, and when temporarily bolted together they are skidded to the second and third positions where they are then reamed and riveted. In the fourth position the end ladders, roof-frame brackets, and other parts are applied, the ends as completed being then placed opposite the final assembling position.

The Final Erecting

As the trucks are assembled and painted, they are delivered from the truck shop and enter the erecting shop by the side door immediately ahead of the underframe and side-frame jigs, where they are turned on a turntable and placed in position on the assembling track. The underframe completed in the riveting jig is then lifted by the overhead crane and placed on the trucks, the slings are released, and a steel end is next placed in position and bolted on the end farthest away from the side-frame jigs; the side frames are then placed in position, and finally the second end, along with the center and side-sill cross-ties. The brake-cylinder reservoir and piping are also applied at this time.

The car is then moved by car haul to the second position where the assembled members and the roof framing are riveted in place. In the third position the safety appliances, brake rigging, couplers, uncoupling rods, etc., are applied, the remainder of the riveting completed, and the entire frame is then sprayed with the priming coat of paint ready for finishing.

Finishing the Car

The steel frames are switched each day to the wood freight-car shop where the decking, sheathing, roofing, and doors are applied and the painting operations are completed. The decking is of 1¾-in. red pine and the sheathing of 1½-in. Douglas fir, both having tongued-and-grooved joints. High-grade lumber free from knots, checks, or cracks is selected for this purpose and is then kiln dried, the moisture content being carefully limited in order to prevent the possibility of further shrinkage later on; the only objection of any importance raised against the steel-frame box car, as compared with other box cars, having been one arising from improper drying of the sheathing. After being machined the sheathing is again examined, and any boards checked or cracked in drying are set aside and used for lining the ends of the car.

Paint by Spraying Machines

Before leaving the planing mill the sheathing, roofing, and running boards receive their priming coat of paint in a painting machine recently developed at the Angus shops and which differs from those in use elsewhere. The boards on leaving the matcher pass automatically through the painting machine, where they are sprayed by a series of nozzles which can be set in any desired position according to the surfaces required to be painted. The paint is drawn up through suction pipes from the bottom of the box by means of air jets blowing across the nozzles, and as ejected it is atomized by the air and blown on to the boards in the form of a fine spray. The amount of paint to be applied is controlled by air valves or by regulating the speed at which the boards pass through the machine. No brushing or wiping is necessary. The boards on leaving the machine are piled on trailer trucks and distributed by tractors to the shops when dry. These machines will paint at the rate of 200 running feet per minute, which is about as fast as the boards can be conveniently piled for drying.

Car Completed and Ready for Service

The first operation in the wood freight-car shop is to apply the decking, the joints of which are previously coated with a thick paint compound, as are also the ends of the boards making contact with the bottom boards of the side sheathing previously applied.

The side sheathing which has already received the priming coat of paint is next applied, and to insure that the sides of the car will be watertight, the joints are coated with paint compound, after which they are wedged down into position and bolted to the framing. The end lining is then applied in a similar manner but vertically. In the succeeding operation the roof is applied, the boards and metal sheets of which have previously been primed.

After the doors are hung in place and the remainder of the safety appliances have been installed, the car is given two additional coats of paint and stenciled, when it is complete and ready for service.

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A. R. A. Mechanical Division Meeting

Various guesses have been made as to the reason for the elimination of the June conventions as we have known them for so many years. But, strange to say, in spite of their glorious and enjoyable past, there are but few expressions of regret over their temporary cessation. This fact has already been discussed in the columns of this paper.

There was a time when the life of the two great mechanical associations was looked upon as on something perpetual.

In the case of the meeting that is to be held in Chicago this month the advance copies of the papers have brought in but an individual paper and that one on the apprenticeship system as applied on the Atchison, Topeka & Santa Fe.

There are two committee reports that must have required a deal of effort to prepare, one on car wheels and the other on the specifications and tests for materials. The latter was prepared by a committee made up, with one exception, of engineers of tests, and from the names, includes the best known men in the country, holding those positions.

Comment on the details of these reports and papers must necessarily be deferred until after their presentation to the convention, where it is to be hoped, they will receive the attention, in the form of discussion, that they deserve.

Progress Report on Constructive Program

R. H. Aishton, President of the American Railway Association, appeared before the Interstate Commerce Commission on May 28 at the opening of the Commission's investigation into the adequacy of locomotives and cars and general railroad facilities. He said the following encouraging results have been obtained by the railroads in compliance with their program "to provide adequate transportation":

Closed cars have been moved from the east to the west in anticipation of the crop movement.

Open cars have been moved from the west to the east to move coal this summer.

From January 1 to May 12 a total of 17,029,946 cars of revenue freight have been loaded, compared with 14,278,847 cars in the corresponding period last year, and 13,311,555 in the same period in 1921.

Locomotives in need of heavy repairs have been reduced to 19.4 per cent and freight cars to 9.2 per cent in line with the provision of the program, which calls for equipment in need of heavy repair to be reduced, in the case of locomotives to 15 per cent and in the case of cars to 5 per cent, by October 1.

From March 15 to May 1, 28,613 freight cars have been ordered, bringing the total of cars on order May 1 to 115,765.

Purchases from January 1, 1922, to May 1, 1923, have totaled 252,257 cars, of which 136,501 have been delivered.

In the sixteen months from January 1, 1922, to May 1, 1923, 4,463 locomotives were purchased, of which 2,607 have been installed, and 1,956 were on order May 1.

The single disturbing feature is the labor shortage, which "is slowing up deliveries of material necessary for the maintenance and operation of the railroad."

Details of Expenditures

Dr. J. H. Parmelee, Director of the Bureau of Railway Economics, who followed Mr. Aishton, said that reports filed by the railroad showed that in 1922 and 1923, the railroads have either expended or authorized expenditures totaling $1,540,214,419, of which amount $923,020,201, or 60 per cent, was for equipment, while the remaining $617,194,218, or 40 per cent, applied to tracks and other facilities.

In 1922, alone, $431,542,115 were expended for new cars and locomotives, tracking and other facilities, of which amount, the witness said, $246,502,929, or about 57 per cent, represented additional equipment or improvements to equipment. In that year approximately 72 per cent of the $246,502,929 were expended for freight train cars alone.

The total for all purposes in 1923, Dr. Parmelee said, is approximately $1,108,672,304, of which amount 61 per cent, or $676,500,000, was for equipment, while the balance of 39 per cent, or $432,000,000, represented improvements to road. Of the total authorization for equipment, he said, $415,000,000, or 61 per cent, was for freight train cars.

Western Shippers Question Valuation Conference

At the Railroad Valuation Conference called by Senator La Follette and others, held in Chicago on May 25 and 26, it must have been rather disconcerting to the Senator to have a committee of business men, headed by J. P. Haynes, traffic director of the Chicago Chamber of Commerce tell them there was nothing seriously wrong with the railroads and that Chicago shippers were more vitally concerned with good railway service than with politicians who pay no freight bills, and that they had marveled at what the roads had done in buying new equipment and placing themselves in a position to meet traffic needs. This committee which represented the largest shippers in the West presented the Senator with a series of questions to which a reply was requested, but to which none has yet been made.

Among the questions were the following:

"You, Senator La Follette, made the assertion in the Senate May 31, 1910 (Congressional Record, page 7140), that all the railroads in the United States could be valued at an expense not exceeding $2,400,000, and that such a valuation would save the country in transportation charges in twelve months more than 150 times the cost of making the valuation of the physical property of the railroads."

"Valuation has been proceeding for ten years, yet not one of the great Eastern systems has been valued, even tentatively, while to June 20, 1922, this work has cost the government $23,058,000 and the railroads $62,885,000, a total of $85,945,000. One hundred and fifty times this amount, which you said would be saved, would be $12,891,450,000, which is much more than twice the aggregate gross earnings of all the railroads last year. Will you kindly explain to the satisfaction of your fellow citizens the remarkable discrepancy between your promise and its fulfillment?

"Assuming that railroad valuation is too great by $7,000,000,000, as Senator Brookhart alleges, rates based on a valuation reduced $7,000,000,000 would save the public less than 6 per cent in freight and passenger rates on the basis of present actual earnings, expenses and taxes, or an average of $3.50 per capita per annum, as any one can ascertain for himself.

"This fact being indisputable, it is pertinent to ask if this conference is not in reality a 'press agent stunt' staged to prejudice the people against the railroads and thus promote the political advantage of the so-called 'Progressive' bloc."

Loyalty and Some of its Elements

By W. E. SYMONS

The question of loyalty to one's country, home, family, friends or Creator is never difficult of solution by one whose heart is in the right place and stands four square for a square deal, and this finds no more fitting application than in the attitude of the great army of railroad officers and employes toward scheming politicians who seek by their insidious propaganda to hamper, harass and financially embarrass the railway managements in their efforts to restore public confidence and put their companies on a firm financial basis.

One of the latest forms in which this pernicious propaganda is being used to further poison the public mind against all corporate interests, but particularly directed against the railways, is a move by certain men high in political circles, to influence the Interstate Commerce Commission against allowing the railways a fair valuation on their property.

When reduced to its proper basis this is nothing more or less than a move to so cripple and hamper the carriers financially as to render private ownership and management impossible, and thereby pave the way for government ownership and finally turn the railways into the greatest political machine ever known—one that in its ramifications would so far exceed anything "Boss Tweed" ever dreamed of, that there could be no comparison.

The railways of this country give employment to about 1,800,000, of whom more than 20,000 are officers, while several millions derive their support from, and should be interested in the prosperity of this industry, and each one of these should individually and collectively apply themselves to counteracting in so far as lies in their power this insidious propaganda.

The railroads are seeking to have a fair valuation placed on their property, and ask that the Interstate Commerce Commission shall in passing on this matter treat them in accordance with the provisions of the Constitution as interpreted by the courts, and the claims of certain propagandists that an excess or fictitious valuation of about $10,000,000,000 is sought by the railways is without foundation.

Mr. Railroad man, are you going to sit idly by with arms folded in an apparent disinterested manner, when your own place of business is in jeopardy? Or, will you speak out plainly and forcibly in language void of ambiguity, to every fellow workman, business man, politician, labor leader and office holder demanding a fair square deal for the railways, and thus place yourself among those who are grateful for, and wish a continuation of present prosperous conditions in an industry which will suffer from a decided slump if this insidious propaganda should attain any appreciable degree of success?

Railroads' Wage Bill Last Year

Last year the total wage bill of the Class I railroads, including 15 switching and terminal companies, was $2,669,180,772, and it was paid to an average number of 1,645,244 employes, according to a special report of the Interstate Commerce Commission.

In January, 1922, 1,552,014 men were on the pay rolls of the railroads, which number had increased by the end of December to 1,788,590. The average wage for all classes of railroad employes, exclusive of executives, officials and staff assistants, was $1,622.36.

The average salary paid to 15,502 executives, officials and staff assistants was about $5,027.

The average number of professional, clerical and general forces employed during the year was 283,254, who received an average yearly wage of $1,574.58.

The average number of maintenance of way and structures employes was 363,788, who received an average yearly was of $1,058.17.

The average number of maintenance of equipment and stores employes, which group includes the shopmen, was 453,313, who received an average yearly wage of $1,648.39.

The average number of employes in transportation service, other than train, engine and yard service, was 204,712, who received an average yearly wage of $1,408.85.

The average number of yardmasters, switchtenders and hostlers in transportation service was 23,592, who received an average yearly wage of $2,096.79.

The average number of train and engine service men, which includes locomotive engineers and firemen, was 302,083, who received an average yearly wage of $2,224.28.

Analyzes Traffic Increases of 1922

A special report of the Bureau of Economics shows a summary of operating statistics of Class I railroads of the country in 1922, compared with 1921.

In 1922 train-miles totaled 554,780,000, compared with 530,141,000 in 1921. Freight car-miles totaled 20,890,000,000 in 1922, compared with 19,847,077,000 in 1921. The gross ton miles in 1922 totaled 813,051,515,000, compared with 760,716,420,000 in 1921.

The average tons per train, excluding locomotive and tender, were 1,466 in 1922, compared with 1,435 tons in 1921, while the net tons per train were 677 in 1922, compared with 651 in 1921.

The per cent. of loaded to total car-miles in 1922 was 67.2 per cent., compared with 63 per cent. in 1921.

Improved Type of Grain Car—South African Railways

By W. E. SYMONS

The railways of the United States as a whole need offer no apology as to development in design, construction and operation of locomotives, freight and passenger cars, although there is room for greater improvement, and in some particular features others may have surpassed us.

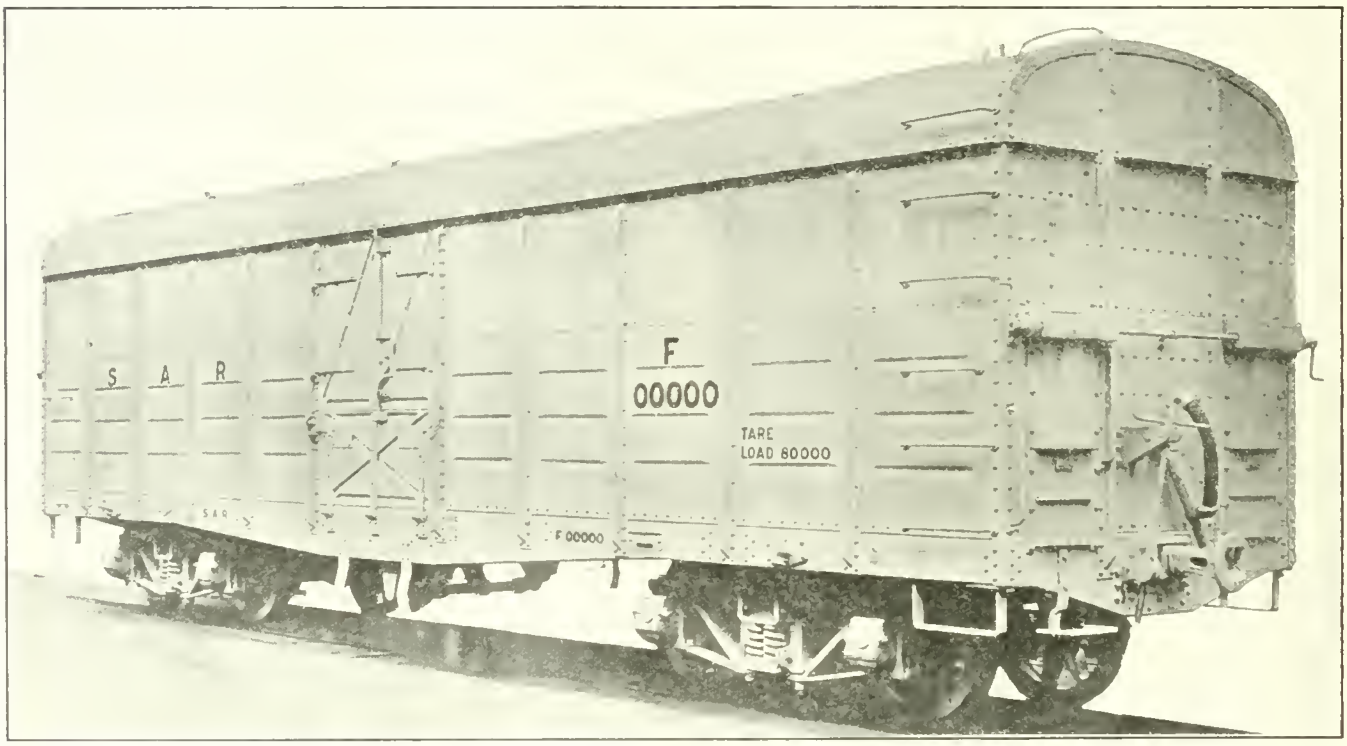
In the matter of special types of freight cars for a particular commodity or service we have of course made wonderful progress, as is evidenced by the numerous different designs of refrigerator, dairy and milk, poultry, cattle, ventilated fruit, tank and other types intended to promote the interests alike of both the shipper and carrier, and while taking due credit for our progress in this respect we may well give credit to our friends of the South African Railways for having developed a freight car for handling bulk grain, from the designs of which we may well learn many interesting and valuable points.

With a freight car equipment of 2,380,036 cars roughly valued at about $3,500,000,000, handling 1,331,490,158 tons of freight per year, 106,994,912 tons of which is products of agriculture, largely bulk grain, and with more than 1,000,000 box cars, we still load and unload most all bulk grain by the rather expensive and archaic side door method, while our friends, in a country which many of us think of only in connection with hunting big game or old King Tut's tomb, have designed and placed in service a modern grain car, with facilities for loading through the roof, and unloading at either side doors or at end doors, or by hoisting one end of the car to an angle of say 35 to 40 degrees from the horizontal, thus effecting much economy in time and expense loading and unloading, while the car has many other advantages from a traffic and transportation standpoint over the conventional box car.

Through the courtesy of Mr. W. R. Collins, chief mechanical engineer, we have been favored with a detailed description of this car.

In connection with the introduction into South Africa of the modern method of handling grain in bulk by the installation of elevators at the principal ports and farming centres throughout the Union, the Railway Administration placed orders with British firms for the supply of three special steel cars of experimental designs to work in conjunction with the new loading system.

The first of these cars to be completed was built by the Metropolitan Carriage, Wagon and Finance Co., at their Ashbury Works, thereafter being shipped in sections to South Africa where it was re-erected in the Administration's workshops, at Durban. This car, with the sole exception of the inside grain doors, is of steel construction throughout, and has several special features embodied in the design to suit the unusual methods of loading and discharging.



Improved Type of Grain Car in Use on the South African Railways

The vehicle is built to work on the 3 ft. 6 in. gauge track of the Union Railways, and has a carrying capacity of 80,000 lbs., its weight in complete running order being 40,210 lbs., thus giving an axle load of practically 30,000 lbs. or 13.4 long tons when loaded to its maximum carrying capacity.

The car is intended for loading from overhead grain bins, and for this purpose four suitably spaced steel doors of special construction are fitted in the roof on the centre line of the car. These doors consist essentially of rectangular, dished steel plates with rounded corners, inverted over the upturned edge of a flanged seating ring of "L" section whose lower limb is securely riveted to the roof sheets. By this means a weather-tight construction is assured. The flange of the door being kept clear of the seating ring and its edge being well below the door joint there is no possible chance of rain water finding its way in. The doors can be securely battened down by means of screws and wing nuts which are fitted on the opposite side to the hinges. All four doors can be locked by a common bar, carried in brackets on the roof, and with a series of pins which engage into eyebolts on each of the closed doors. This locking bar is operated from one end of the car, where a gravity catch is fitted, and can be sealed by means of a wire, in such a manner that pilfering and inadvertent loss of grain are obviated.

A special feature of the design is the arrangement of grain discharge doors at each end of the car. The door openings, of which there are two in each end of the car, are placed at 5 ft. 2 in. centres and with their lower edges flush with the floor plates so as to offer as little obstruction as possible to the flow of grain when the car is being tilted up endwise through an angle of 35 degrees, as arranged for in the hydraulically operated tipping device. These grain outlets are 1 ft. 4 in. square and have a pressed steel deflector plate placed between them, forming half a diagonally divided square pyramid in shape, which is flanged and riveted to the floor plate and car ends on the inside. The central deflector, in conjunction with others placed between the outside edge of the door openings and the car sides, entirely prevent a static accumulation of grain when the car is being emptied on the tipping device, and ensures a cleaner, quicker, and easier discharge than would be the case were the grain sliding over itself instead of against a polished metal surface. The end doors are made of 5/16 in. plate stiffened by two transversely disposed angles, and working vertically in guides fixed to the car ends, can be raised or lowered as desired through the agency of cast steel racks riveted to their outer face. These racks are geared with cast steel pinions carried in bearings secured to the car ends above the doors. A roller is fitted immediately behind each pinion to act as a support to the rack against which it bears and to prevent it buckling. The pinions operating each pair of doors are keyed to a common shaft which is carried horizontally across the full width of the car, and being fitted with a detachable handle at either end, it is possible for one man to operate both doors simultaneously, while they may be held in any position desired by rackets and pawls which are fitted to each of the bearings nearest the handles. When closed the doors are perfectly grain tight, and, in common with the loading doors on the roof, they can be securely locked. All gearing and operating gear is encased by guard plates to prevent risk of their being damaged.

Although primarily designed for unloading on the special devices which would be installed at the elevator centres, it is thought possible that unloading can be carried out with the car in its normal running position without resorting to an appreciable amount of shoveling. Under these circumstances the laborers would enter through the roof doors and shovel the grain through the doors in one or both ends of the car.

The general utility of the design has been greatly increased by making it suitable for the conveyance of ordinary merchandise. A high-capacity car will thus be available for the conveyance of goods when occasion arises, besides which the loss of revenue due to hauling an "empty" on the return journey from the elevator stations will be partly obviated. This has been achieved by the introduction of side doors into the design, in a manner similar to that followed in the ordinary box car. The side doors are of pressed steel type on the three section principle. The two upper doors, which are 5/23 in. steel plate, each one-half width of the doorway, open towards and fold back against the car side when fully opened. They work independently of the lower door, and are carried on steel hinges secured to the door stanchions. The door lock is of the S. A. R. standard pattern with eccentric operating cam and a long door bolt of square section whose upper end forms a tee head engaging with a socket on the cantrail, while the lower end passes through a socket on the lower door.

The lower section of the door extends the full width of the doorway and is 2 ft. 3⅛ in. high. It is arranged to open downwards and is carried on three hinges secured to the solebars. Door stops of spring steel are fitted to the underframe, and corresponding striking plates on the door. These doors have to withstand a good deal of rough usage through continually striking against the stops, besides being often used as ramps when lowered on to station platforms, and for these reasons are of heavier construction than the others, being made of 3/16 in. plate, deeply ribbed. They are held in the closed position by a door pin passing through brackets on the door stanchions, and over the extended end of the outer door hinges. The lower end of the door bolt and the flange of the upper doors also help to keep them in position.

With this style of door it is impossible to make and fit them with sufficient accuracy to ensure grain tight joints, and for this reason it was found necessary to provide another set of doors inside the car, which could be more readily and surely sealed. These inner doors are made in halves, arranged to hinge inwards. To carry them, and at the same time form a surface against which their beveled edges could make a joint, teak pillars are bolted to the inside of the door stanchions, and teak sills and head rail bolted to the floor and cantrail respectively. The doors are teak framed 1¾ in. thick, with a 5 in. by 1¾ in. centre rail, and with two layers of 6 in. by ⅞ in. red deal match boarding, laid diagonally in the frame, the two layers running in opposite directions to give additional strength and prevent warping. A strip of piano felt, ⅝ in. by ⅜ in. is let into the four edges of the doors, and being pinned and glued in position forms a joint through which the finest seed or grain cannot pass. The outside faces of the doors are sheathed with 20-S. W. G. galvanized plate, to serve as a protector against damage when opened back during the carrying of ordinary merchandise. The doors are 6 ft. 2½ in. high and are each carried on two hinges bolted to the stanchions, and when closed during the carrying of grain they are locked by means of a 2½ in. by ½ in. steel bar which is pivoted at the centre of its length on to one door pillar and rests in a horizontal position in brackets secured to the door frames. When the doors are required to be held open this bar is swung into a vertical position and held there by a spring clip on its door frame; the doors are then swung back against the car sides and are held there by a retaining catch which drops into a clip fitted just below the centre of the door.

The car sides are constructed of ⅛ in. steel plates, very strongly supported upon pressed steel staunchions riveted to the solebars. The lower plates are constructed with three deeply-pressed ribs in the space between stanchions, to give stiffness against the tendency such thin plates would have to bulging outwards. The stanchions, to which the car sides are attached, and which hold them in position against the horizontal pressure of the load, and of centrifugal forces when rounding curves, are pressed from 5/16 in. steel plate to a "U" shaped section, the two limbs of the "U" being flanged outwards to afford a means of attachment to the body and underframe. The stanchions are tapered in the direction of their length, being deepest in section at their bottom ends where the tendency to bending is greatest.

Special consideration has been given to the design of the car ends, which have to safely withstand not only the racking stresses due to braking and buffing but also those caused during the discharging process when the car is tilted endwise. Sufficient strength in this direction has been gained by the use of two pressed steel stanchions riveted to the headstocks with their outside edges just clearing the discharge doors, and by the use of thicker plates for the ends, which are 3/16 in. steel. To eliminate the bulging tendency and also securely tie the corner angles and two stanchions together, two stiffeners have been riveted horizontally across the ends of the wagon on the inside. They are each 9⅛ in. wide of ¼ plate and pressed out 1 15/16 in. to a special section with an inclined top face, so as not to obstruct the downward flow of grain when emptying. One is placed immediately below the pinion bearings, and the other about 9 in. below the cantrail level. They are clearly shown on the photograph by a double row of riveted heads in the positions named.

The roof is built of ⅛ in. plate with angle iron cantrail and carlines and with butt joints and cover plates. As shown on the photograph it has a curved top which combines elegance of appearance and design with the necessary clearance for passing fixed structures. The roof is also stiffened crosswise—to counteract any spreading tendency—by two cross braces of ¼ in. plate on edge. These braces are 9½ in. deep at centre, and are held between two carlines placed back to back and riveted to the roof joints and cantrails, between the first and second, and the third and fourth loading doors. The floor consists of 3/16 in. steel plates with butt joints and is secured to the underframe with countersunk rivets, to give a smooth surface.

The load is distributed over an underframe built up of pressed steel members of the well-known Fox's construction. The solebars are in one length, flanged throughout to form a channel section, 4 in. wide at the flanges, 7/16 in. thick, and varying in depth from 9 in. at the ends to 1 ft. 3 in. at the centre of the span. This deepening of the solebar to the middle allows of an economical distribution of metal, because the strength of a girder increases as the square of its depth, and an evenly loaded girder—as in this instance—should have a parobolic outline, to which form these solebars are the nearest practical approach, and being thus virtually "self-supporting" no trussing gear is required. The headstock is of ⅜ in. pressed steel plate, deepened in the centre to accommodate the buffing and drawgear and to make provision for the fitting of safety chains should such be required in an emergency.

The crossbearers, forming the car bolster and carrying the top centre pivot and side friction bearings, are of pressed steel channel section, 9 in. by 3½ in. by ⅜ in. They extend in one length from the solebars. The longitudinals run parallel, at 12 in. apart, from end to end of the underframe, a feature which, although it has the disadvantage of placing the vacuum brake cylinder on one side of the frame, gives much greater strength to resist buffing stresses and obviates unduly straining the bolster. The centre longitudinals extend in one piece between the inner of the bolster crossbearers, to which they are attached by angle knees, and are similar in shape and depth to the solebars, except that the flange width increases from 3½ in. at the ends to 5 in. at the centre, to give greater strength. The end longitudinals carry the buffing and drawgear which is of the central "Johnstone" type, with 2¾ in. diameter shank and our standard type of heavy compound spiral spring, reacting against steel "U" plates riveted to the webs of the longitudinals. These "U" plates also serve the purpose of stops to limit the range of the buffer to 3 in. and 2 in. on the buffing and draw strokes respectively.

The underframe is given additional lateral stiffness by pressed steel cross members fixed to the longitudinals at intervals between the bolsters. The junction of the members at the bogie is strengthened by steel gusset plates riveted to their bottom flanges, and to these the cast steel top pivot and side friction plates are bolted. These wearing parts are lubricated from oil boxes, made of pressed steel and bolted between the bolster crossbearers. They are loosely packed with oilsoaked waste, and protected from dirt and dust by wooden covers. The oil is led to the wearing faces by copper pipes passing through the box into the oil grooves in the castings.

The trucks are of the well-known "Diamond Frame" type.

The wheels are of the spoke type and 2 ft. 10 in. diameter on tread, the tires being secured by means of "Gibson" rings.

The brake is of the automatic vacuum type, the necessary power being supplied by a 21 in. cylinder of the "separate" type (i. e., with a separate vacuum chamber). The cylinder is made of cast iron and is suspended by wrought iron trunnions fitting into lugs cast on the cylinder wall. These trunnions are hung, free to rotate, in hangers rigidly bolted to the underframe members. The piston is of cast iron with india-rubber rolling ring, and the piston rod is brass sheathed. The pull of the piston is increased by a system of levers attached to a brake shaft carried in rigid hangers, and the gear is "compensated" by a freely hung bell-crank lever which equalizes the force applied to each truck pull rod. A handpower brake, operated by means of a handle and screw at one end of the car, is also fitted, for braking purposes when the car is disconnected from the engine and running free. The brake screw is of the pillar type, as is fitted to our latest type of high-capacity cars.

Mild steel retaining hooks are fitted to both solebars at both ends of the cars, just beyond the truck centres, for the purpose of attaching the steel wire retaining ropes holding the car in position when tilted up on the tipping platform. There will be two 1¼ in. steel ropes used on this device, attached by means of shackles to each side of the car, and it is estimated that each retaining hook will have to withstand a pull of 15 tons when a full car is tilted to an angle of 35 deg. The hooks are secured to the solebar with six ⅞ in. rivets each.

The car was completely erected and tested at the maker's works before being shipped to South Africa. The following are the leading dimensions:

Length inside	36 ft. 11⅛ in.
Width	7 ft. 11 in.
Height from floor to roof at centre	8 ft. 3 in.
Length over headstocks	37 ft. 0 in.
Width over solebars	7 ft. 11¼ in.
Width centres of trucks	24 ft. 0 in.
Truck wheelbase	5 ft. 9 in.
Height from rail level to top of loading doors (light vehicle)	11 ft. 9⅝ in.
Width over roof at carline	8 ft. 4½ in.
Size of grain loading roof doors (4)	2 ft. 8 in.x1 ft. 9 in.
Size of grain discharge end doors (4)	1 ft. 4 in.x1 ft. 4 in.
Diameter of wheels	2 ft. 10 in.
Size of journals	5 ft.x10 in.
Tare weight	40,210 lbs.
Carrying capacity	80,000 lbs.
Gross load	120,210 lbs.
Axle load	13.4 long tons

The South African Railways operate about 11,500 miles of railway, have 1,834 locomotives, 32,161 freight cars and

3,007 passenger cars. They handled last year 15,220,762 tons of freight, 1,078,634 tons of which was grain, and their total earnings were $104,000,000.

The points of criticism of this car are the vacuum brake and the coupling device which we do not think are as efficient as the improved compressed air brake and automatic couplers used here, but this does not affect or detract from the more important features which should be studied by our railway men and car designers.

The roof of this car is an integral part of and contributes to the strength of whole unit or complete structure, while at the same time it provides for quick loading at a minimum cost of all bulk grain from elevators. These roof openings are also available for ventilation or other purposes and in this respect alone it is a great improvement over anything we have, for in the matter of freight car roofs alone there has been for years and is now a demand for an efficient roof that is weather proof, fool proof, and that will be an *asset* to the car body, not a *liability*.

New Pacific Type Locomotives for the Louisville & Nashville R. R.

The Louisville and Nashville has recently added eight new passenger locomotives to its equipment. These engines are of the Pacific (4-6-2) type and they were built by The Baldwin Locomotive Works. They are the largest passenger locomotives thus far placed in service on this road, and in general design follow the light Pacific type built for the United States Railroad Administration during the war period. The details, however, have been generally revised to suit the Railroad Company's standards.

These locomotives are designed to traverse curves of 19 degrees and to operate on grades up to 2 per cent. They develop a tractive force of 40,700 pounds and carry 160,000 pounds on driving-wheels, so that the ratio of adhesion is very nearly four. This is a high tractive force in proportion to the weight, and it is backed up by ample steaming capacity. The boiler contains a superheater and brick arch, and labor saving accessories include an air-operated fire-door and a coal pusher on the tender.

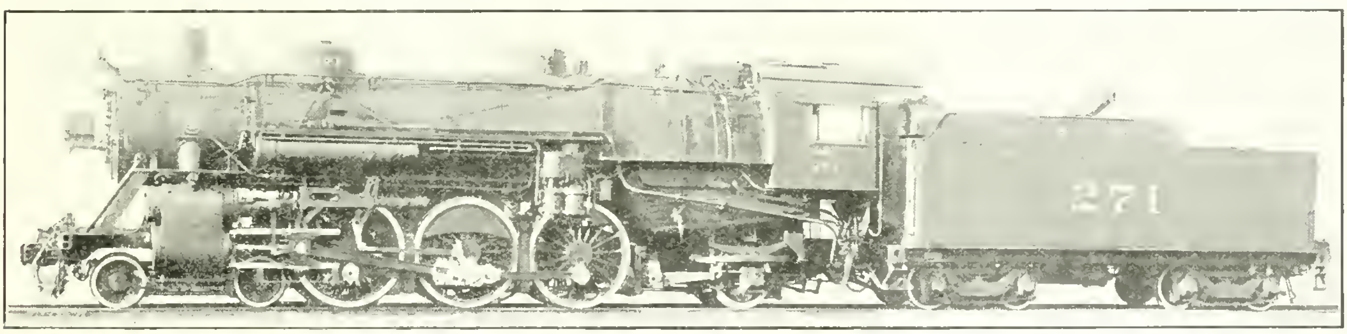
The cylinders and steam-chests are bushed with gun-iron, and the valves, which are 14 inches in diameter, are operated by Walschaerts valve gear, controlled by a power reverse mechanism. The valves are set with a maximum travel of 6½ inches and a lead of ¼ inch, and they have a steam lap of 1⅛ inches and an exhaust clearance of ¼ inch.

The leading truck is of the constant resistance type, and has solid rolled steel wheels, as have also the tender trucks. The pilots are sufficiently short to permit two locomotives to be coupled together head on.

A cast steel rear frame cradle is used on the locomotive, and the tender has a one-piece cast steel frame, so designed that a mechanical stoker can be subsequently applied if desired. The construction of the tender also permits the future application of a water-scoop.

This is an excellent representative of a modern passenger locomotive, built to conservative dimensions and equipped for the special conditions to be met. The principal dimensions are given in the table:

Type of locomotive	4-6-2
Cylinders, diameter and stroke	25" x 28"
Valves, piston type	14" diam.
Weights in working order:	
On drivers	160,000 lb.
On front truck	58,100 lb.
On trailing truck	58,200 lb.
Total engine	276,300 lb.
Total engine and tender	469,000 lb.
Wheel bases:	
Driving	13' 0"
Rigid	13' 0"
Total engine	34' 11"
Total engine and tender	70' 6¼"
Driving Wheels:	
Diameter outside tires	73"
Boiler:	
Type	Wagon Top
Steam pressure	200 lb.
Fuel	soft coal
Diameter	76"
Firebox, length and width	114⅛" x 84¼"
Tubes, number and diameter	36—5½"
Tubes, number and diameter	188—2¼"
Length over tube sheets	19' 0"
Grate area	66.7 sq. ft.
Heating surfaces:	
Firebox, comb. chamber and arch tubes	269 sq. ft.
Tubes and flues	3,072 sq. ft.
Total evaporative	3,341 sq. ft.
Superheater	836 sq. ft.
General data, estimated:	
Tractive force	40,700 lb.
Service	Passenger
Tender:	
Water capacity	10,000 U. S. gal.
Fuel capacity	16 tons



Pacific or 4-6-2 Type Locomotive for the Louisville and Nashville Railroad—Built by the Baldwin Locomotive Works

How Feed Water Heater Helps the Engineer

The first question that naturally occurs to the locomotive engineer, when some new device is applied to the locomotive he is running, is—"What does this so-called fuel saving or efficiency increasing appliance mean to me personally?" "Is it actually going to help me get over the division on time with regularly scheduled trains, or in less time on freight runs and with 'extras'?" "Will it prove of real assistance to me in making the grades and in reaching close meeting points with a few minutes to spare, even when hauling more than the usual number of cars?" "Is it going to be so easy to operate that it will not distract my attention from other more important duties—and will it be free from failures and troubles on the road?" The real value of the feed water heater to the engineer is readily appreciated by applying this list of questions to this particular device.

Getting Over the Road

"How is this device going to help you get over the road more easily?" It will do this, primarily, by increasing the steam generating capacity of the locomotive. To make this point clear it should be explained that where an injector is used to supply the boiler, the temperature of the feed water is raised many degrees by live steam taken directly from the boiler. This means that part of the fuel burned in the firebox goes to generate this steam which is used to heat the water passing through the injector.

The purpose of the feed water heater is to reclaim a portion of the heat of the exhaust steam from the locomotive cylinders which would otherwise be lost, and use this heat to raise the temperature of the boiler feed water. It is plainly seen that in doing this the feed water heater relieves the boiler of a certain amount of work necessary if an injector were used, and this materially increases the steaming capacity of the locomotive boiler for the same amount of fuel burned.

For example, in the case of a locomotive with 200 lbs. steam pressure, 150 degrees superheat and 40 degrees tender water temperature, the claim is made that the Worthington feed water heater will increase the steaming capacity 13.5 to 14.5 per cent depending on exhaust steam pressure.

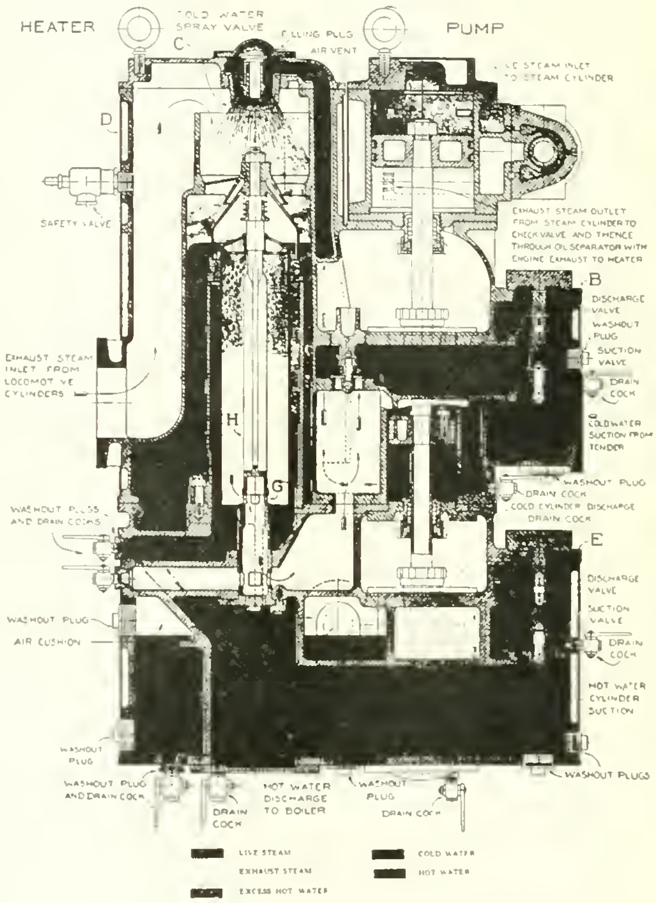
This increase in locomotive steaming capacity can, perhaps, be more clearly shown as follows: A Mikado type locomotive which evaporates on an average of 6¾ lbs. of water per pound of coal with an injector, can evaporate 27,000 lbs. of water with 4,000 lbs. of coal per hour. The same locomotive when equipped with a Worthington feed water heater will evaporate approximately 29,900 lbs. of water with the same amount of coal.

There is still another way in which the Worthington feed water heater is of great assistance to you in getting over the road on time and in less time, and that is because of the fact that it is an open heater. The exhaust steam condensed in heating the feed water mixes directly with the water taken from the tank. This means that the heater will recover from the exhaust steam from 13 to 16 per cent of the total water supplied to the boiler. This water saving is equivalent to a considerable increase in tender water capacity, and enables you to pass more water plugs on the road without stopping to fill the tank.

From the foregoing it is apparent that the feed water heater will prove a vital factor in helping you get over the road, by decisively increasing the steaming capacity of the locomotive, and materially reducing the amount of water used on the road.

Making Grades and Meeting Points

How does the feed water heater assist you in making the hill or help you in "hitting her up" to reach a meeting point on time? It does this by increasing the steam generating capacity of the boiler at the very time when you are working the engine hardest and need this help most. This is a peculiar advantage offered by the feed water heater. When the locomotive is working the hardest on heavy grades, or in starting trains, the increased amount of heat furnished by the exhaust to the feed water is of great assistance at just the time when boiler capacity is taxed to the utmost. Also in extremely cold winter weather, when trains are difficult to handle, the feed water heater comes to the rescue by utilizing the waste heat of the exhaust to maximum advantage in raising the temperature of the extremely cold water supplied from the tank, thus assuring more freely steaming locomotives just at the critical time when they are most needed.



The Worthington Feed Water Heater

Ease of Operation

Coming to the third question—"Is the feed water heater easy to operate?" Yes. It is much easier to operate than an injector, as a slight turn or adjustment of the pump throttle valve is all that is needed to maintain a constant water level under all operating conditions. Wherever the Worthington is used, engine crews invariably prefer it to the injector. It can be operated continuously at low capacities and can be kept in operation without attention from engine crew, even when the steam pressure is very low. It is not necessary for the engineer to take his attention from track or signals even for a moment, to regulate feed water supply, as the heater pump responds instantly to the slightest turn of the throttle. There is nothing to worry about or distract your attention as in the case of an injector "breaking" or refusing to function properly. It is so simple in construction, being virtually a feed pump, that there is practically nothing to fail, and break-downs in service are therefore unknown.

New Design of Lifter for Type "D" Couplers

The Committee on Couplers and Draft Gear of the Mechanical Division of the American Railway Association have had called to their attention recently, some trouble with the lock lifters of the "D" Couplers, wedging or sticking when the coupler is in locked position. In extreme cases, the lifter could not be raised sufficiently to unlock the coupler, making it necessary, therefore, to remove the coupler from service.

An investigation of this trouble developed that the lifters of a few of the "D" Couplers were working their way down under the anti-creep ledge as indicated on Figure 1, which shows this development in a coupler removed from service. This condition is brought about by extreme wear combined with minimum gauge parts in the coupler.

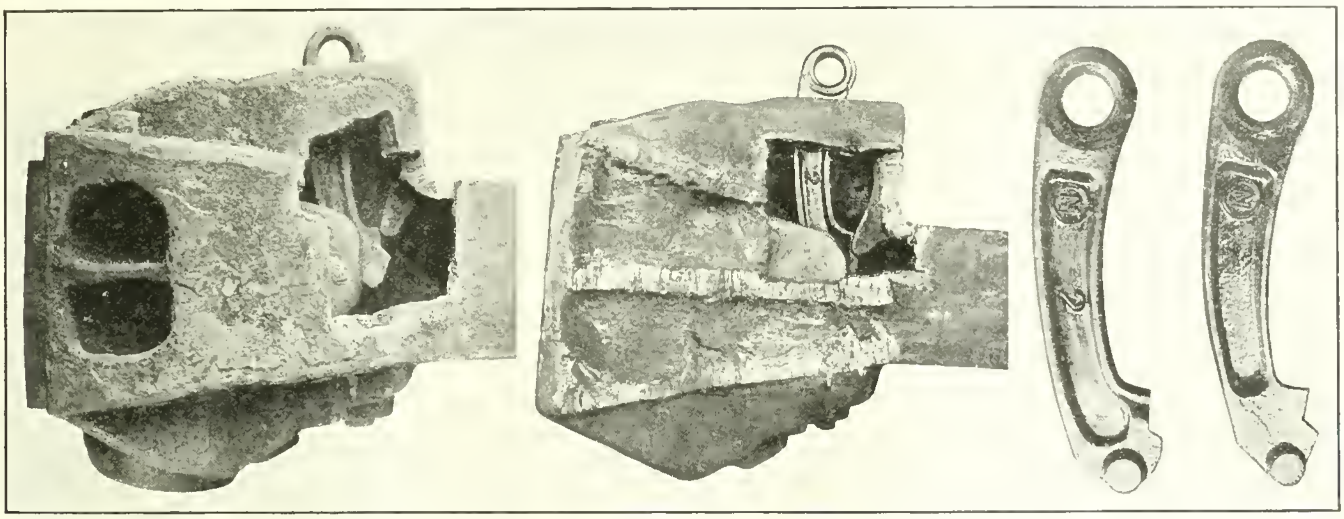


Fig. 1 Showing Old Design of Lock Lifter Wedged Against Anti-Creep Wall

Fig. 2 Showing New Design of Lock Lifter Applied to Coupler

Fig. 3 Showing New and Old Design of Lock Lifter

In order to overcome this trouble, the design of lifter has been slightly modified to compensate for wear that has developed and application of the modified lifter to couplers giving trouble in service has corrected the same. Figure 2 shows the relation between the lifter and anti-creep ledge with a modified lifter applied to a coupler that was giving trouble in service. Figure 3 shows the new and the present design of the lifter and will be of assistance in distinguishing the two designs. The modified lifter is interchangeable with the present design and all lifters manufactured in the future will be of the modified design. This modified design of lifter is designated as "D" Coupler Lock Lifter No. 2.

When "D" Couplers are found to be inoperative on account of the lifter wedging as above indicated, the modified design of lifter should be applied. The Coupler Manufacturers are in position to make immediate deliveries on the modified design.

It will be seen that there is very little difference between the two designs. The new is the one shown at the left in the engraving and has the I section carried down a little further and has the end curved instead of being on a right line.

Demonstration of the M. & L. Booster on the Delaware & Hudson

A demonstration of the M. & L. Booster that has been in process of development on the Delaware & Hudson Railroad for the past three years, was made on the tracks of that road on June 5, in the presence of about seventy-five officers of the mechanical department of a number of railroads and other engineers.

The demonstration consisted of the hauling of a heavily loaded train up an 8 per cent grade, with the frequent cutting in and out of the booster. There was a dynamometer car attached to the train immediately back of the tender, by which a record of the tractive effort exerted was recorded.

The visitors were afforded an excellent opportunity to witness the operations of the mechanism. This was effected by a train of three flat cars, provided with a railing, which was hauled on an adjoining track and kept opposite the booster. In this way the spectators were close to it at all times.

Owing to the limited time available it has been impossible to prepare a complete description of the demonstration for this issue, but it will be taken up and fully treated, together with the details of the construction of the booster itself, in the July issue of this paper.

A Scholarship in Mechanical Engineering

Columbia University has tendered a scholarship in mechanical engineering to the American Society of Mechanical Engineers. The matter of placing the scholarship has been placed in charge of the Woman's Auxiliary of the society and any inquiries should be addressed to it at the headquarters, 29 West 39th St., New York.

This Woman's Auxiliary is patterned after a similar organization connected with the mining engineers. It was proposed and organized in March, and at once took up the matter of filling the scholarship vacancy with the deans of a number of the technical schools, from whom a few applications have already been received.

This auxiliary is of recent formation and is the outgrowth of the Ladies' Committee which has, heretofore, had charge of some of the social events of the annual meeting. In addition to the social functions exercised by its predecessor it will be active in the promotion of scholarships in mechanical engineering and the distribution of technical literature.

Frank McManamy—Interstate Commerce Commissioner

Sketch of the Experience and Training That Has Fitted Him for This Important Position

Winthrop M. Daniels has resigned as a member of the Interstate Commerce Commission to become Strathcona professor of transportation at Yale University and Frank McManamy, manager of the department of equipment in the Division of the Liquidation of Claims of the United States Railroad Administration, has been appointed by President Harding to fill the unexpired term of the resigning commissioner. The announcement is a simple one and yet it is safe to say that no appointment, heretofore made, has attracted the widespread attention and interest in railroad circles as this one. The probable reasons are that Mr. McManamy has been prominently before the railroad public for years in his official capacity as a subordinate of the Interstate Commerce Commission and has taken a lively interest in all affairs relating to the mechanical equipment; because he is the first employe, of the commission to be promoted to commissioner with the exception of Mr. Morble who was secretary of the commission and was appointed to succeed Mr. Lane when the latter entered the Wilson cabinet, and because it is the first recognition that the mechanical department of the country has had on the commission. Any one of these reasons would have made the appointment a notable one. And to these may be added a fourth that it is doubtful if any man has ever brought to his seat, as commissioner, a wider and more intimate knowledge of the duties of the position, of the problems that confront it and the workings of the great system of transportation that it is authorized to regulate. Certainly he has served an apprenticeship that must have given him a training and experience that none of his predecessors have known.

Born near Altoona, Pennsylvania, on September 3, 1870, he at first received only that education which can be gained in the common school, supplemented later, by two terms at a teachers' normal school; and, then, at the age of fifteen he started out to gain the training that was to fit him for this last appointment. The start was made as a water boy in the construction department of the Pennsylvania Railroad, and the work was in the clearing of the right of way for a branch line. Then came a step up to be a member of a section gang working at track laying and general maintenance.

Five years later, in 1890, he went to Michigan and obtained employment in the shops of the Chicago & West Michigan Railroad at Muskegon, now a part of the Pere Marquette. A year later he became a locomotive fireman.

He was then twenty-one years of age and joined the firemen's union, taking out a card and with it a life insurance policy based on his age at the time, the payments on which he has kept up. It was while firing a locomotive on a freight run of 150 miles a day on this road, that he attended a business college in Traverse City, and later he spent about two years reading law under the instructions of Mr. F. A. Nims of the firm of Smith, Nims, Hoyt & Irwin of Muskegon. A course of study that was discontinued when he left the railroad service.

After six years of firing he became an engineer and two years later, in 1899, he resigned to accept the position of air brake instructor for the International Correspondence Schools of Scranton, Penna. Here he had an opportunity for developing that faculty for organization that he has so markedly displayed. He had charge of the building and equipping of some of the schools' air brake instruction cars, of which there were, at one time, fifteen in service. Later he became assistant manager of the railway department and then engineer of tests in charge of one of the dynamometer cars that was used for making tonnage and fuel tests.

His service with the school lasted for nine years, during the whole of which he was acquiring an intimate, first hand knowledge of locomotive performances.

Then, in 1908, he passed an examination for the position of inspector of safety appliances with the Interstate Commerce Commission with a rating of 96 per cent.

He entered the service on February 8, of that year, and held the position of inspector for a little more than three years, or until March 3, 1911. On that date he was appointed assistant chief inspector of locomotive boilers by President Taft. He then became known to outsiders and the railroad world in general, with a broadening of his reputation to the present time. Following the death of the chief inspector, J. F. Ensign, he was appointed to the place of chief inspector of locomotives by President Wilson on October 30, 1913, and held it until January 1, 1918.

While in the employ of the commission as safety appliance inspector, he served on the committee which prepared the safety appliance standards for cars, and, as assistant chief inspector of locomotive boilers, assisted in the preparation of the locomotive boiler inspection rules. As chief inspector of locomotives, he was in charge of the locomotive inspection rules under the locomotive inspection law, as amended.

Frank McManamy

In the preparation of these standards and rules, the method of procedure was to send out requests for copies of the practices and standards of the roads of the country and, then, by a process of assimilation and elimination build up a code that represented the best practice, and this in consultation with the departmental heads of the railroads.

Later and for several months prior to the assumption of Federal control, he had charge of special investigations concerning the condition and maintenance of railroad equipment, acting under the direction of the Interstate Commerce Commission.

At the beginning of Federal control he was, on the request of the director general, assigned by the commission to take charge of equipment matters for the railroad administration, and on July 1, 1918, he was directed by the director general to resign his position as chief inspector and to devote all of his time to the work of the railroad administration in the capacity of assistant director of operation in charge of mechanical matters. In this capacity he was actively engaged in the preparation of the designs for standard locomotives and freight cars, a work that was done by a committee of representative superintendents of motive power together with experts chosen from the builders of locomotives and cars.

The results of the work of this committee are now a part of the mechanical history of the country, and the administration locomotives, as they are called, that were designed by it, are generally regarded as exceptionally well designed for the purposes for which they were intended.

Later he was chairman of this committee on standards for locomotives and cars which passed upon matters pertaining to their construction and to the appurtenances that should be used.

On the assumption of Federal control, one of the principal problems confronting the administration was that of improving the condition of locomotives and cars. The war was upon us, labor and new machinery were scarce, and an increase of facilities and of shop forces was out of the question. The railroads had, to a great extent, made contracts with their men based upon a nine-hour day and requiring but fifty-four hours a week of labor. These agreements were recognized as binding on both sides, and the only way out of the difficulty seemed to lie in persuading the men to waive their rights as to the time element of the agreements and consent to the substitution of a longer working day.

Mr. McManamy immediately called a conference with the representatives of the employes and presented the case of the exigencies of the hour with which everyone is familiar, and reached an understanding with them that so long as the condition of the equipment required it, they would waive the provisions of their agreements and work seventy or more hours per week. This understanding was confirmed by the director general by letter on February 14, 1918, and remained in effect until the fall of 1918, when the equipment was in such condition that it was no longer necessary, at which time Mr. McManamy was authorized by the director general to put the eight hour day into effect again. This letter of the director general, in effect, constituted a uniform working agreement for all of the railroad employes of the country and was, in reality, the foundation of the national agreement, for it simply amounted to an application of the agreements that were already in existence on the southern and southwestern roads to the northern and eastern roads whereon no such agreements were in existence. But, in this application, a number of changes were made by which they were made less restrictive than they had been in their original form.

The situation was a delicate one and needed careful handling. The agreements in force had been built up after years of negotiation between officials and employes, and the difficulty of adjustment was great.

For example: Two railroad systems have terminals in the same city. Each has an agreement with its employes. The wages paid on each were the same for the particular system, but different, one from the other. Under Federal control all of the men are working for the same employer, the government. A difference in wages on the two roads, in the same city, naturally created dissatisfaction among those receiving the lower, and, in order to avoid this, the adoption of a uniform rate was the only solution.

Then in the fall of 1918, after the armistice, railroad employes who up to that time had been working for the Railroad Administration at lower rates of pay than were being paid in outside industries made a request of the director general for a standard set of working rules. This resulted in a conference committee composed of about forty superintendents of motive power being called to Washington to confer with representatives of the employes to formulate such rules. After about five months' work this committee had agreed on about ninety rules and disagreed on about one hundred, and the matter was then referred to the Board of Railroad Wages and Working Conditions for final conference and decision. Hearings were held by this board for about three months, which left the matter still unsettled. These conferences had dragged on so long that the employes were beginning to question the good faith of the director general and he was accused of stalling to avoid making an agreement of any kind. The director general then called into conference Mr. Tyler, the director of operations; Mr. Carter, the director of labor, and Mr. McManamy to see what could be done. Mr. McManamy recommended one of two things: either that the men be flatly told that they could have no standard working agreement, or that the government proceed to negotiate such an agreement to a conclusion. It was decided to negotiate an agreement, and under the direction of Mr. Tyler, Mr. McManamy was assigned to the task.

In the latter part of August, 1919, he met a committee of one hundred representing the shop crafts, and after eight days' negotiation, working about 14 hours daily, what is in effect the standard agreement, was completed and submitted to the director general, Mr. Hines, for approval.

Mr. Hines went into this agreement very exhaustively and either OK'D or corrected every rule, after which Mr. McManamy again met the committee and obtained their agreement to the corrections made by Director General Hines.

This working agreement resulted in stabilizing conditions at the end of the period of Federal control, removing grounds for disputes, and avoided the necessity of each individual railroad beginning negotiations with their own men immediately thereafter, and it remained in effect until changed by order of the Labor Board, which substituted certain principles in which the vital points of the national agreement were preserved. These principles are still the basis of all of the working rules of the railroads in the country.

The result of the national agreement was that the railroads were returned to their owners and their employes satisfied with their working rules, and working on a rate of pay from twenty to thirty per cent less than was paid for similar work in outside industries. This was recognized when the Labor Board, following Federal control, gave an increase of from twenty-two to twenty-seven per cent in the rates of pay to all railroad employes.

The effect of increasing the shop hours early in 1918 from an average of about fifty-four hours per week to seventy hours per week was to increase by approximately twenty per cent the output of locomotive shops in classified repairs and to increase the number of cars turned out with heavy repairs 73,000 per month. It was this work that made it possible to handle the traffic of the country without requiring locomotive and car builders to turn their plants into repair shops and thus stop the output of new equipment which was being urged by a great many, both in and out of railroad service. By increasing the output of railroad shops, the locomotive builders were free to turn out the greatest number of new locomotives in their history, not only for service in this country but for export and for the use of our troops in France.

An interesting feature in connection with the construction of new locomotives which illustrates what the railroad administration was called on to do is the case of a certain railroad which had twenty-five mikado locomotives under construction at the American Locomotive Works. Late one night the American Locomotive Company called the railroad administration by long distance from New

York and stated that a certain railroad had canceled its order for these locomotives after they were under construction and the material distributed through the shop. The result of this cancellation would have slowed up their shop output at a time when it was most desirable that it be kept to the maximum and would have deprived the railroad administration of the use of these locomotives.

The call came to Mr. McManamy and he advised the company that the railroad administration would authorize the completion of the locomotives, and would arrange for the railroad's inspector to return at once to the locomotive company's shop so that the work could proceed without delay. This was done the next day by long distance telephone. The locomotives were finished and paid for by the administration and put in service in the coal carrying districts.

The director general raised no question as to authorizing the completion of this equipment and the American Locomotive Company did not hesitate a minute to proceed with the work as a result of a telephone conversation with Mr. McManamy at Washington.

During the first year of Federal control, under the measures adopted by the railroad administration, 2,757 new locomotives were put in service.

As an illustration of the improvement in shop conditions which resulted from putting shop forces on increased working hours, Mr. S. M. Vauclain, chairman of the Advisory Committee on Plants & Munitions, requested assistance in construction of locomotives for our armies in France, and a committee, selected by him, was authorized to investigate conditions at certain railroad shops so that all of their specially heavy duty machines might be utilized to their maximum capacity, if not on railroad work, on new locomotives.

As a result of the improved conditions of the shops the railroad administration, during the summer of 1918, assisted the Baldwin Locomotive Works in the construction of new locomotives. To illustrate, the Philadelphia & Reading shop at Reading was planing and slotting frames; the Delaware, Lackawanna & Western was planing frames and rods; the Lehigh Valley was planing frames and driving boxes; the Erie was finishing shoes, wedges and cylinders; the New York Central was building new boilers, and at other points similar work was being done.

Since the close of Federal control Mr. McManamy has been conducting all of the investigations for the railroad administration in connection with the settlement of claims covering equipment. This has been a tremendous task and has involved the adjustment of hundreds of millions of dollars in claims. It has involved a check of expenditures during the test period and a comparison of such expenditure equated to Federal control prices with the expenditures during Federal control, as under the standard contract such a comparison has been made the measure of maintenance. In this work an investigation has been made on every railroad under Federal control, their accounts checked, a vast amount of data showing physical condition investigated and a report rendered on which the settlement of the claim could be based.

And from this last duty he steps into the chair of a commissioner. Surely none of his colleagues or predecessors can lay claim to a more thorough preparation for the place.

And what does it mean to his colleagues? Here we have ten men exercising, under the Esch-Cummings bill, an almost autocratic control of the regulation of the transportation of the country. Of these, six are lawyers, one of whom had been a railroad president, and the others had made their place and reputation in the filling of various public offices. Two have grown up in the public service, but without railroad experience, and have won their spurs as commissioners of state regulating bodies. One was a silk merchant and president of the Commercial Travelers' Association, and one was an economist, a professor of political economy and a lecturer on sociology. Since the resignation of the Hon. Edgar E. Clark only one has had any railroad experience and he as an executive far removed from the practical details of mechanical operation. Now this commission is called upon to regulate the use of safety appliances, the care and inspection of locomotives, the installation and adoption of train controls, signals and the thousand and one details that enter into the construction and operation of locomotives, cars and track. Surely a man who, for nearly forty years has been in training along these lines must be a valuable acquisition as the eleventh one in such a group of men freighted with such responsibilities and his value to them as a colleague and adviser as to these things, with which he has been so intimately connected, cannot fail to be of inestimable value to them in the reaching of decisions, and therefore, to the country at large. Hence it is that the importance and value of the appointment is so emphasized, not only of itself, but as establishing a precedent that it will be well to follow. Hence it comes about that President Harding is to be congratulated, not only because he has promoted a man from the staff of the commission to a membership therein, but, in doing it, has selected a man thoroughly drilled in the work that lies before him.

Meeting of the New York Railroad Club

At the monthly meeting of the New York Railroad Club, which was held in the Engineering Society's Building, 29 West 39th St., New York City, on the evening of Friday, May 18, a number of new features were introduced for the benefit and entertainment of the membership.

This was the last meeting of the club until the September meeting in the fall, and among the new features introduced was a get-together-dinner by quite a large number of members who met at the Commodore Hotel and enjoyed a very pleasant hour or so at special tables provided for their special convenience on this occasion by Mr. Ellsworth Haring, Chairman of the Committee on Entertainment. This particular feature is new and bids fair to grow in popularity among the membership, there being a large and representative gathering while many others would have joined had they known of the arrangement.

The paper of the evening was by Mr. I. U. Kerchner, Service Agent of the Pennsylvania system, entitled Training and Inspiring the Supervisory Forces, and outlined in detail a co-operative arrangement which is really an educational feature of their organization, based on the principles of a genuine democracy, in which the Pennsylvania have made great strides in improving the morale of their supervisory or adminstrative officers, and the effect of this has, of course, operated to the benefit of the employe as well as the subordinate and general officers.

The paper was very ably discussed by several members of the club, including Messrs. Brazier, Roy Wright, John Draney, including appropriate remarks by President Dickinson.

Following this paper the meeting was entertained for an hour or more with a series of motion-pictures showing first the care given to the equipment of the subway trains, in the way of inspections, repairs, etc., and second, how the subways handle the enormous crowds which they are called upon to handle daily, introducing in this feature the experience of a patron who for convenience was designated as Mr. A. Strap Hanger.

The entire series of pictures were not only interesting and instructive, but embraced a number of rather amusing incidents which held the audience in a good natured and receptive mood.

Both the features of the get-together-dinner prior to the meeting and the introduction of the moving-pictures, it is predicted will have a beneficial effect in stimulating enthusiasm among the members of the club and doubtless result in increased attendance and added interest in the fall meetings.

Railway Supply Trade Building in Chicago

The Railroad Supply and Equipment Exchange Corporation has been incorporated for the purpose of erecting in Chicago a large building to be used as a central headquarters for the Railway Supply Trade of the United States. The building, as planned, will be large enough and of a design to accommodate permanent transient exhibits of railway equipment and supplies, and also furnish office space for supply manufacturers and their representatives, the upper floors to be used for club rooms.

Harry Vissering, president of the Harry Vissering & Company, Chicago, is president; T. G. Kroehler is vice-president and R. W. Lyons is secretary and treasurer. It is planned to design the building for exhibits that will remain in place for long periods. The first floor will be given over to freight and passenger cars and locomotives. The second floor will hold lighter machinery, tools, signaling devices and other railway supplies. About 14 floors above the exhibition floors will be allotted to offices for supply companies at a rental which it is calculated can be made much less than present rates in many offices. The upper floors of the building will be made into from 300 to 350 rooms with sleeping accommodations; also a swimming pool and a gymnasium. It is also planned to arrange on one of the upper floors an auditorium which may be used by conventions. The district favored for the location of the building is north of the Chicago river and near the Municipal pier. Arrangements have been made for financing the construction of the building and these will be put into effect when tentative leases have been secured.

Increased Employment and Average Wage

The number employed by Class 1 steam roads in March, 1923, was 1,816,479, to whom $255,447,764 was paid in wages, according to a report just made public by the Interstate Commerce Commission. The average wage per employe was $140.63.

The number employed on the railroads in March represented an increase of 246,321, or 15.7 per cent over the number reported for the same month last year, and an increase of 32,924, or 1.8 per cent, over the number for February, this year. The total compensation in March this year was 17.9 per cent greater than in March a year ago.

The Commission's report shows that in March, this year, 16,216 executives, officials and staff assistants received an average salary of $423.

Professional, clerical and general forces reported on a daily basis numbered 49,042 and received an average wage of $179. This class of employes on an hourly basis numbered 232,722 and received an average wage of $124.

Maintenance of way and structure employes on a daily basis numbered 4,655 and received an average wage of $239. This class of employe on an hourly basis received an average wage of $91.

Maintenance of equipment and stores forces on a daily basis numbered 17,575 and received an average wage of $243. Those on an hourly basis numbered 574,179 and received $131.

Employes in the transportation department, other than train, engine and yard service, numbered 26,628 on a daily basis and received an average wage of $95, while those on an hourly basis numbered 187,081 with an average wage of $124.

Yard masters, switch tenders and hostlers on a daily basis numbered 6,039 and received an average wage of $253. Those on an hourly basis numbered 10,415 with an average wage of $152.

Train and engine service employes in the transportation department numbered 344,329 and received an average wage of $201. Train and engine service employes are on an hourly basis of pay only.

Westinghouse Electric & Manufacturing Company

The annual report of this company not only affords abundant proof of its prosperous condition from a financial standpoint, but what is more important, that the employes are prosperous and contented, which in these troublesome times speaks volumes of praise for the management and suggests that those who may be in conflict with their working forces might well pattern after the Westinghouse plan in dealing with labor.

As evidence of the continued interest this company has in its employes we quote herewith two paragraphs from the annual report, pertaining to housing conditions and insurance:

"The increase in property account is chiefly due to the purchase from the Emergency Fleet Corporation, of approximately two hundred dwelling houses located near your works at South Philadelphia, Pa. These houses are now being offered for sale to employees in the South Philadelphia Works. No important additions to the present manufacturing facilities are at present contemplated.

"The relations between the company and its employees are satisfactory. Under the company's insurance and savings plan 66% of the number of employees on March 31st, 1923, owned insurance of $500 or more each. Since the inauguration of the plan, death benefits aggregating $524,500 have been paid to the beneficiaries of 574 employees. The deposits by the employees in the 'Savings Fund' are accumulating at a rate in excess of $100,000 a month and the total savings at this date are in excess of $2,000,000. The savings are invested for the benefit of the employees under the direction of your Board of Directors and are not used in any way in the company's operations."

A company that obligates itself for two hundred houses for employes, has 66 per cent of its employes members of an insurance savings plan, has paid out more than a half million dollars in insurance benefits, and has in excess of $2,000,000 in the savings fund for their protection, and finally has a satisfied and efficient force is certainly on a solid foundation.

To achieve such results requires a high order of executive ability.

Test of Automatic Straight Air Brake

By the Interstate Commerce Commission

Because of some of the testimony given at the recent hearings on power brakes before the Interstate Commerce Commission, the latter has decided to make another review of tests of that brake. Arrangements have, therefore, been made with the Norfolk & Western Railway for these tests which will be started on July 9. The details of the schedule have not yet been made public, but the announcement is made that the work will be thoroughly done under the direction of the Bureau of Safety, and that it will occupy a force of inspectors for about thirty days.

Snap Shots By the Wanderer

There are many things in this world that are very interesting, and it is a curious coincidence that most interesting things are also useful. Among the items of this class, is that of the stress that is put upon the rivets in the foundation ring of a locomotive boiler. The present day boiler maker has but little idea of the troubles of his predecessors of years ago because of this thrust. The boiler that did not leak at the corners of the water leg was an exception, and an exception of such a short life that it soon qualified as a regular. The first hint at something better, came, as I recollect it, from John Mackenzie, at a Saratoga convention of the Master Mechanics' Association. He told how he had stopped the leaking at the corners of his foundation rings by the very simple process of making them with a downwardly projecting lug at that point and double riveting the sheets. That little speech was the forerunner of a complete revolution in mud ring construction. The double-riveted corners were at first used, but long before they became universal in their application, the double-riveted ring was adopted, and is now in universal use, or so nearly so that the statement can be made that it is, without much fear of contradiction.

Superficially considered, it would appear that the opportunity of firmly fastening a smooth sheet to the ring was such that the two pieces of metal could be held so securely that there would be no possibility of a separation and consequent leakage between them. But there is a tendency to leak.

Investigations that have been partially outlined in this paper show that there is a buckling and bending of the inner sheet of the firebox during the whole of its period of active service, and that this buckling is greatest near the foundation ring. Of course if the sheet had an opportunity to expand freely under the influence of heat there would be little tendency to buckle. But as it does buckle, the point of interest is the amount of shearing stress that it puts upon the rivets of the ring. We might guess at it, but the probability of making a correct guess would be very slim.

That this thrust is probably very great is shown by the behavior of some boilers of the Wootten type, whose rings have been bent outward by as much as 5 in., or 6 in., at the center.

That an extraordinarily heavy pressure must have been exerted upon the ring in order to produce such a distortion is very evident, though as to exactly where it comes from we are still very much in the dark.

That the tubes push the back tubesheet to the rear and the firebox with it, is well known, necessitating the use of slackly applied flexible stay bolts in the throat sheet, in order to avoid an otherwise inevitable breakage. Steam pressure cannot account for it. Two hundred pounds pressure per square inch on an area of sixteen square inches would never break or even give a permanent set to a stay bolt one inch in diameter and made of good iron. Yet a week would be a long life for throatsheet stay bolts of the rigid type in certain boilers. So, if we knew as to just what these pressures are, it would be of interest and probably of some value in remedying the trouble.

* * *

There was a lawsuit recently in the course of which testimony was given to the effect that name and good will was of no value to a circus. You and I may doubt the reliability of such testimony if we hark back to our boyhood days and remember how the missing of Robinson's circus would have been regarded as a calamity of the first order, and our children may even look upon Barnum & Bailey in the same light. But aside from circuses, there seems to be a well-defined opinion that a name may have a distinct money value. And the courts are holding that a man may not only have a right for protection in the use of a name, but in a business as well.

A certain King Solomon once remarked that "there is nothing new under the sun," and the statement appears to hold when an attempt is made to establish the novelty of an invention in court. As soon as a commercial success is made of any device there is sure to be some one or ones who try to come in and reap what others have sown. Then, when the original promoter feels aggrieved and institutes a suit for the infringing of his patents, the experts straightway gather in a mass of antedating patents and other literature to prove that the patent upon which the suit is based should be declared null and void. This is easy, so easy, in fact, as to have brought the activities of the professional patent expert into disrepute. It would be a novel invention indeed that out of the million odd that have passed the patent office inspection, some one or more could not be found that remotely resembled it.

But the courts have come to give a more liberal interpretation to the claims of a patent than they did some years ago. Decisions are being based not only upon the actual specifications, claims and details of the construction of a patent but on what the owner has done towards its commercial development.

If an original patent has been allowed to lie fallow, or the mechanism constructed in accordance with it has not been developed into a commercial or mechanical success, and a newcomer takes the old idea and makes it into a practical device, retaining the fundamental construction of the original the courts are apt to hold that such a man is entitled to patent protection.

This may be a violation of the technicality that requires novelty in invention, in fact inventing or finding out implies novelty but it certainly is quite in accord with the principles of equity.

More than one successful commercial device of the day rests upon such a decision. I can recall one such case, where the patent drawing and the device itself was an exact replica of something that had gone before. The earlier one simply could not attain the results obtained by the later one and the courts held that the designer of the last was entitled to protection and he has built up a large business on the basis thereof.

The sad part of the matter is the indifference of the public to the real rights of the man who has accomplished something for their benefit. It is so easy for people to cultivate a spirit of hostility to the successful man, that they rush to support an infringer who may be, in spirit, little better than a common thief, but who hopes for a legal endorsement of his misdeeds.

Human nature is weak, very weak, and too many of us agree with Falstaff in his famous soliloquy on the battlefield on honor.

But if by some means we could persuade ourselves to stand by the originators, the men who have done and accomplished, and whose rights are based on an equity that we can readily see, it is probable that the fees of lawyers and the number of patent suits would be immeasurably decreased.

International Railway Fuel Ass'n Convention

Railway Fuel—A Reducible 13% of Operating Costs is the Subject of Opening Address by Julius Kruttschnitt, Chairman of the Southern Pacific Company

The fifteenth annual convention of the International Railway Fuel Association was held at the Hotel Winton, Cleveland, Ohio, May 21 to 24 inclusive. The sustained interest in the proceedings of this young, healthy and useful association, which has accomplished so much good among railway men since its organization was indicated by the registration which showed 630 in attendance.

The outstanding contribution to this convention was the opening address of Julius Kruttschnitt, Chairman of the Board of the Southern Pacific Company, entitled, Fuel—A Reducible 13% of Expense, which was a comprehensive survey of the possibilites for fuel economy, which dealt with the present existing problems and future developments looking towards reductions in fuel consumption.

Many able men have addressed this association at its annual meetings, but none have so far brought out so clearly the essential points in the location, construction and operation of a railway as Mr. Kruttschnitt, and this is not strange, for the reason that few men are able to handle the subject from so many angles of view, all of which however have to do, in some way, with fuel economy.

Among the more salient points brought out were the following:

1. The total consumption of railroad coal per year is 137,000,000 tons.
2. The cost of fuel to the railroads was $594,479,000.
3. The relation this item bears to total expense is 13%.
4. Quantity of coal burned in stand by losses 29,000,000 tons.
5. Value of coal burned in stand by losses, $125,860,000.
6. Economies possible on item of fuel alone. Millions.
7. The disposition heat value of the coal burned in a locomotive is as follows:

Results of Combustion	Making steam	70%
	Waste heat out of stack	14 "
	Cinders out of stack	8 "
	Unburned gases	4 "
	Ash pan and ash pit	4 "
	Total	100%

The 70 per cent of the remaining heat in coal stored in the form of steam is disposed of as follows:

Distribution of heat units	Exhausted from stack	51%
	Radiation	5 "
	Operating air pumps, injectors, etc.	7 "
	Useful work at draw bar	6 "
	Total	70%

The percentage of useful work can be increased from 6 to 8.1 per cent or about 35 per cent, by the use of certain devices of known merit among which may be mentioned the following:

Fuel Saving Devices	Superheater	20%
	Feed water Heaters	6 "
	Brick arch	9 "
	Total	35%

To this estimate may be also added the increased earning power of a locomotive equipped with a booster, which will increase the tractive effort or hauling capacity of a heavy freight engine about 10 per cent and as much as 25 to 35 per cent to a lighter passenger locomotive.

The loss resulting from hauling 5,000 lbs of extra dead weight per freight car of same capacity is shown to be $9.12 per car per year, and of course on several thousand cars this item is soon expressed in millions of dollars.

Where electric current can be generated from water power, electrification of steam railways show much economy, but where the current is generated in a steam plant the economies are not so well established.

This very interesting and valuable paper closes with the following summary which should be carefully studied by all who are interested in fuel economy or economical railway operation.

It would seem that the hope of the future for conserving fuel lies in:

1. Substituting hydro-electric current for steam, as our best steam locomotives can now fully equal the efficiency of electric locomotives using current generated in steam power stations.

2. Substituting steam turbines or compound condensing or turbine condensing engines for the simple engines now used on our locomotives. From progress already made in Europe, the solution of this problem appears encouraging.

3. The discovery of a cheap, high-gravity fuel that can be used in some such engine as is used on automobiles and airplanes.

4. Reduction of the weight of Diesel engines sufficiently to permit of their use as locomotive engines. Claims have been made that by compounding Diesels can be made to weigh about one-sixth as much as they now do, but as yet these claims have not been substantiated, in the form of a commercially practicable engine.

5. The development of a satisfactory variable speed transmission gear, to couple the Diesel engine to the driving wheels of a locomotive, which will weigh very much less than the electric generator and motor, would go far towards establishing the Diesel engine as a locomotive prime mover.

Addresses were also made by J. N. Clark, president of the association, who expressed his appreciation of the whole response of the railway executives to his requests that they have representatives at the convention; by T. K. Maher, president of the Maher Colleries Company, Cleveland, and H. M. Griggs, manager of the Ore and Coal Exchange, Cleveland. The latter gave an outline of the work of the exchange which serves as a clearing house for information relative to the exchange of lake and rail traffic in coal and ore.

The subjects of the individual papers presented to the convention were published in the May issue of Railway and Locomotive Engineering, and we will publish extracts from these in later issues.

Election of Officers

The following officers were elected to serve for the coming year: President, M. A. Daly (Northern Pacific); vice-presidents, J. W. Dodge (Illinois Central); P. E. Bast (Delaware & Hudson), and J. R. Evans (Chesapeake & Ohio). J. B. Hutchinson (Pennsylvania) is the secretary-treasurer.

The new members of the executive committee are: J. E. Davenport (New York Central), H. T. Bentley (Chicago & North Western), E. E. Chapman (Atchison, Topeka & Santa Fe), C. H. Dyson (Baltimore & Ohio), and W. J. Capp (Denver & Rio Grande Western).

Air Brake Association Convention

The 30th annual convention of the Air Brake Association was held at the Albany Hotel, Denver, Col., May first, second and third. President Mark Purcell presided, and in his opening address said that to a large extent the high state of efficiency and economy reached in railway transportation is due to brake control. Without such control, the number of trains that could be handled would be very much less, because the trains would have to be spaced further apart and the speed restricted to prevent accidents. W. R. Scott, president of the Southern Pacific, Texas & Louisiana Lines addressed the convention. Mr. Scott's remarks dealt with the early history of the air brake, its development and the relation of automatic train control to brake operation.

The following papers were read and discussed:

Expediting Train Movement, by the North-West Air Brake Club; Charging Freight Trains and the Use of Release Position, by W. F. Peck (Baltimore & Ohio); Causes for Slow Operation of Locomotive Air Compressors, by the Pittsburgh Air Brake Club; Feed Valve Tests, by the Manhattan Air Brake Club, and two papers on the 8½-in. cross compound compressor, one by the Central Air Brake Club and one by the Dixie Air Brake Club. George H. Wood (Atchison, Topeka & Santa Fe), in a brief talk also discussed the relation of train control to the air brake.

At the closing session the following officers were elected for the next year.

President, George H. Wood, A. T. & S. F.; first vice-president, C. M. Kidd, N. & W.; second vice-president, R. D. Burns, Penna.; third vice-president, M. S. Belk, Sou. The following are the members of the Executive Committee: H. L. Sandhas, C. R. R. of N. J.; H. A. Clark, M., St. P. & S. S. M.; W. W. White, M. C.; J. J. Flynn, D. & H.; and William H. Clegg, C. N.

In twenty-two companies, members of the Air Brake Appliance Association had exhibits at the meeting.

Pipe and Nipple Threading Machines With Internally Tripped Die Heads

The Landis Machine Co., Waynesboro, Pa., announces an improved type of pipe and nipple threading machine.

The new Landis pipe and nipple threading machine employs a Landis Internally Tipped Die Head. This type of head automatically insures a uniform length of thread on nipples and eliminates the necessity of ganging each nipple by hand. This new machine will thread, ream and chamfer pipe and nipples.

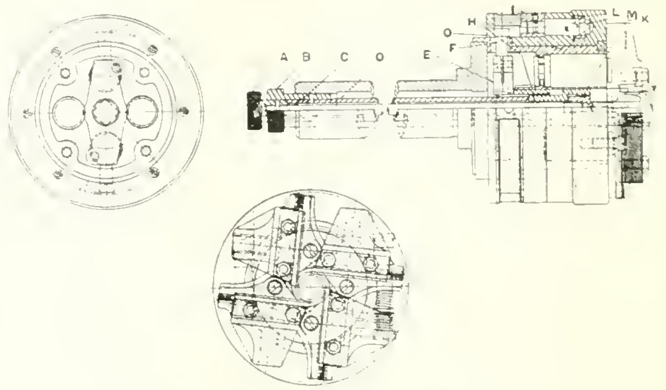
The line cut illustrates the principles of operation of the Landis Internally Tripped Die Head. The knurled collar A and the clamping rod C are integral. The clamping rod C is threaded on one end which screws into a tapped hole in the shank of the reamer K.

The knurled collar B is integral with the tube D. This tube is threaded on one end and screws into the spider E.

The spider E has a square hole through it and furthermore, is tapped part of the way to fit the tube D. This gives thread bearings on the four sides of the square hole. The reaming portion of the hole in the spider is plain to afford a bearing for the driver H.

The driver H has a square hole in the end to receive the shank of the reamer K.

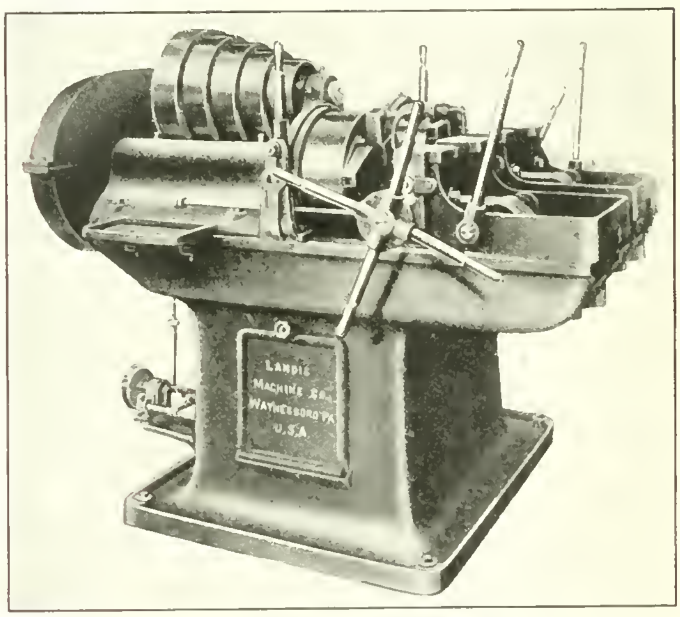
To set the reamer to the correct position, draw the



Details of Landis Internally Tripped Die Head

knurled collar K tightly by hand. This clamps together in one unit, tube D, driver H and reamer K.

The surface Y on the reamer K has no cutting edge, therefore, as the nipple is being threaded and the end begins to bear on reamer K, the units D and H transmit the pressure to the spider E. Through a medium



Landis Improved Pipe and Nipple Threading Machine

of pins F in spider E, rings G and I are carried backward for a distance X or until pin M is disengaged from bushing L. The full opening movement is then completed by a spring in the adjusting ring.

To adjust the reamer K longitudinally, unscrew clamping rod C by turning knurled collar A to the left. Adjust collar B to right or left for either a forward or backward adjustment, depending upon the length of thread to be cut.

This new Landis Internally Tripped Die Head and Machine employs the Landis long life, high speed steel chasers and high speed steel chamfering reamers. It is made in the ½", 1¼", 2" and 4" sizes and in both single and double spindle types.

Notes on Domestic Railroads

Locomotives

The Great Northern Railway Co., is inquiring for prices on 30 electric locomotives.

The Washington Run railroad has ordered one locomotive from the American Locomotive Company.

The Union Terminal Company, Dallas, Texas, has ordered one switching type locomotive from the Baldwin Locomotive Works.

Lyon, Hill & Company has ordered one Prairie type locomotive from the Baldwin Locomotive Works.

The Denver & Rio Grande Western has ordered one superheated rotory snow plow from the American Locomotive Company.

The Atchison, Topeka & Santa Fe Railway has ordered 30 Mikado type locomotives from the Baldwin Locomotive Works.

The Missouri Pacific is having 100 locomotives repaired at Morgan Engineering Works, Alliance, Ohio.

The Portland & Southwestern Railroad has ordered one Mikado type locomotive from the Baldwin Locomotive Works.

The Charcoal Iron Company of America has ordered one Mogul type locomotive from the Baldwin Locomotive Works.

Central of Georgia Railway Company has ordered 5 Mountain type locomotives from the American Locomotive Company.

The Seaboard Air Line Railway has ordered 2 Mikado type locomotives from the American Locomotive Company.

The Missouri Pacific Railroad has ordered 40 Mikado type locomotives and 10 Pacific type locomotives from the American Locomotive Company.

The Lehigh Valley Railroad has ordered 10 Pacific type locomotives from the American Locomotive Company.

The Ching Copper Company has ordered 4, 0-6-0 type switching locomotives from the American Locomotive Company.

The Louisiana & Arkansas Railway has ordered 2 Mikado type locomotives from the Baldwin Locomotive Works.

The Ferrocarriles De Norte De Cuba has ordered 2, 6-wheel switching locomotives from the Baldwin Locomotive Works.

The Savannah & Atlanta Railway is inquiring for two locomotives.

The Niagara Junction Railroad has ordered from the Westinghouse Electric & Manufacturing Company, 2, 43 tons electric locomotives.

The Minneapolis, Northfield & Southern Railway has ordered 2 Mogul type locomotives from the H. K. Porter Company.

The Union Railroad is inquiring for 15 switching locomotives.

The New York, New Haven and Hartford has ordered 5 switching locomotives from the American Locomotive Company.

The Aluminum Company of America has purchased one switching locomotive from the American Locomotive Company for the Alton & Southern.

The Boyne City, Gaylord & Alpena Railroad is reported to have entered the market for two locomotives.

Freight Cars

The Chicago, Burlington & Quincy is inquiring for repairs on 600 to 800 coal cars. Also inquiring for 200 composite ballast cars 50 tons capacity.

The Pittsburgh & Bessemer Coal Company, Pittsburgh, is inquiring for 500 hopper cars of 50 tons capacity.

The Southern Carbon Company, Monroe, La., has ordered 25 tank cars from the Standard Tank Car Company.

The New Haven Gas & Light Company, New Haven, Conn., has ordered 2 tank cars of 10,000 gal. capacity from the Standard Tank Car Co.

The Mexican Petroleum Company, New York, has ordered 50 tank cars of 10,000 gal. capacity and 25 tank cars of 8,000 gal. capacity from the Standard Tank Car Company.

The Seaboard Air Lines Railway Company has ordered 28 caboose cars from Magor Car Corporation.

The Norfolk Southern Railway is inquiring for 100 hopper cars and 100 goudola cars.

The Trimbul Steel Company is inquiring for 75 flat bottom gondola cars of 50 tons capacity.

The Kansas City Southern Ry. Co., is inquiring for 500 box cars.

The Sinclair Refining Company has ordered 10 tank cars 8,000 gal. and 5 tank cars 6,000 gal. from the Standard Tank Car Company.

The Anaconda Copper Mining Company is inquiring for 24 ore cars.

The Public Service Gas Company of Philadelphia is inquiring for 200 hopper cars of 55 tons capacity.

The Fruit Growers' Express Company has purchased 1,000 steel underframes from the Pressed Steel Car Company and 1,000 from the Keith Car & Manufacturing Company.

The Bessemer & Lake Erie Railroad has placed an order for repairs to 500 box cars with the Greenville Steel Car Company.

The Seaboard Air Line Railway is reported to have ordered 400 box cars from the Virginia Bridge & Iron Company. 100 steel underframe box cars from the Richmond Car Works.

The Live Poultry Transportation Company is reported to have entered the market for 200 poultry cars.

The Western Pacific Railroad contemplates the construction of 50 flat cars in its own shops.

The Pere Marquette Railway is said to be inquiring for 25 caboose car underframes.

The Hurley Gasoline Company has placed an order with the Pennsylvania Tank Car Company for 5 tank cars.

The Florida East Coast Ry. Co. has ordered 10 caboose cars and 200 ventilated sheathed box cars from the Mt. Vernon Car Manufacturing Company, and 200 steel flat cars from the American Car & Foundry Company.

The Standard Oil Company is inquiring for 10 coke cars.

The Illinois Traction System Company is inquiring for 100 box cars and 100 coal cars.

The Missouri Pacific Railroad Co. is inquiring for repairs to 350 freight cars.

The Atchison, Topeka & Sante Fe Ry. has ordered 50 express refrigerator cars of 40 tons capacity from the General American Car Company.

The Chicago, Milwaukee & St. Paul Ry. Co. is inquiring for repairs to 300 freight cars.

The New York, New Haven & Hartford Railroad Co. has ordered two transformer cars from the Standard Steel Car Company.

Passenger Cars

The Southern Pacific Company is inquiring for 16 steel buffet and baggage cars 75 ft. long.

The Atchison, Topeka & Santa Fe Railway Company has ordered 25 70 ft. baggage cars from the Pullman Company.

The New York Central Lines is building in its West Albany shops 5 dining cars for use on Michigan Central and the Cleveland, Cincinnati, Chicago & St. Louis. They also let a contract to the Merchants Dispatch, Rochester, New York, for repairs to 100 baggage cars.

The Missouri Pacific Railroad Company has ordered repairs to 25 passenger cars from American Car & Foundry Company.

The Canadian National has ordered 30 steel sleeping cars from the Canadian Car & Foundry Company.

The Florida East Coast Ry. Co. has ordered 15 steel baggage cars two mail cars and 1 dining car from the Pullman Company.

The Pacific Electric Company, Los Angeles, Calif., is inquiring for 50 side door passenger cars, and for 50 electric motor coaches 42 ft. long, also 50 center entrance cars 52 ft. long.

The Chicago & Western Indiana is inquiring for repairs to 28 coaches, one baggage, one mail and baggage, and one mail car.

Buildings and Structures

Illinois Central Railroad has closed bids for the construction of an engine house at Central City, Ky., to cost approximately $300,000.

Michigan Central Railroad Company is calling for bids for additions and extensions to the roundhouse at West Detroit, Mich., Palmer avenue, Detroit, Mich., Bates City Junction, Mich.

The Chicago Rock Island & Pacific Railway Company has closed a contract for the construction of a roundhouse at Shawnee, Okla.

Chicago & Northwestern Railway Company has authorized the construction of a 30-stall roundhouse, a machine and repair shop, a car repair shop and ice house at Madison, Wis. Work will be started shortly and will cost approximately $500,000.

Chicago & Northwestern Railway Company has awarded a contract to G. A. Johnson & Sons, Chicago, Ill., for the construction of a roundhouse at Casper, Wyo.

The Southern Pacific is constructing with its company forces a 16-stall roundhouse, machine shop, power house, car repair shed, mill building, oil house and an employees building at Lafayette, La.

Missouri Pacific Railroad has authorized the construction of a new machine shop at Wichita, Kansas, to cost approximately $78,000. The company has also authorized the construction of necessary facilities for handling fuel oil for locomotive including storage at terminals and outlying supply stations on Arkansas, Louisiana and Memphis divisions which will cost approximately $350,000.

Missouri Pacific Railroad construction contemplated by this company included a new 8-stall engine house at Osawatomie, Kans., which will cost approximately $52,000. The installation of a 100 ft. turntable and additions to an engine house at Van Buren, Ark., to cost approximately $72,000. The construction of a water station and treating plant at Horace, Kans., to cost $55,000.

Pere Marquette Railway contemplates the construction of a 16-stall roundhouse, a machine shop and a service building for the employees, at Erie, Mich.

Southern Railway is reported planning the erection of a 10-story office building at Birmingham, Ala.

Fort Worth & Denver City Railway Co. plans the construction of a new paint and coach shop at Childress, Texas, to replace the building recently destroyed by fire.

Mobile & Ohio Railroad Co. plans the construction of a new machine shop at Jackson, Tenn., to cost approximately $1,250,000.

Galveston, Harrisburg & San Antonio Railway will construct an eight-stall addition to the roundhouse at El Paso, Texas, also an additional blacksmith shop.

New York Central Railroad Co. will construct an additional car repair shop building at Adrian, Mich.

The St. Louis, San Francisco Railway is reported to have completed plans for construction of a large repair shop at East Thomas, Ala., to cost approximately $200,000.

The Bessemer & Lake Erie Railroad is preparing plans for the construction of a one-story machine shop at Greenville, Pa.

The Norfolk & Western Railway is reported to have awarded a contract for the construction of a new locomotive and car repair shops and power house at Shenandoah, Va., to the Pellyjohn Company of Lynchburg, Va.

Southern Railway will construct a new planing mill at Princeton, Ind., and will remodel the old mill and boiler shop at that point. This work to cost approximately $275,000.

Supply Trade Notes

Mr. **F. E. Lister** has been appointed service engineer of the **Franklin Railway Supply Company, Inc.**, New York City. Mr. Lister began his railway service as cotton clerk in the general freight office of the Galveston, Houston and Henderson R. R., Galveston, Texas, in 1898. The following summer he left to become machinist apprentice in the general shop of the International and Great Northern Railway, Palestine, Texas. Three years later he returned to the G. H. and H. at Galveston as machinist. Later he became a machinist in the division roundhouse of the Gulf, Colorado and Santa Fe R. R. at Silsbee, Texas, a position he left to enter the mechanical engineering school of Purdue University, from which he was graduated in 1907. During vacations and after graduation, Mr. Lister worked as a machinist on the Chicago, Indianapolis and Louisville R. R. at Lafayette, Ind., the Pennsylvania at Altoona, Pa., and the Union Pacific at Omaha, Nebraska. In the latter part of 1907, Mr. Lister was appointed manager of the Minneapolis office of the Fuel Engineering Company at Chicago, in consulting work on fuel coal on the B. T. U. basis and on general stationary steam plant efficiency. In 1908 he joined the staff of the Railroad Gazette, New York, as associate editor and after three years with this publication went into the advertising department of the Municipal Engineering and Manufacturer's Record. In 1913 he was made Superintendent of the erecting department of Crown Cork and Seal Company, Baltimore, Md., to organize and operate machine installations-service department. After four years with the Crown Company he left to become works manager of the Humphryes Manufacturing Company, Mansfield, Ohio. In 1918 he joined the Audiffren Refrigerating Company, New York, as engineer. In 1921, Mr. Lister went into engineering and sales work as a manufacturer's representative in New York City, which work he terminated the first of May, 1923, to enter the service department of the Franklin Railway Supply Company, Inc., New York, as service engineer.

C. H. Long, formerly manager of the Contract Section of the Railway Department of the **Westinghouse Electric & Manufacturing Company**, has been appointed a Section Manager of the Light Traction Division of the Railway Department and is responsible for international negotiations and also for stocks and production schedules of the Light Traction Division.

R. W. Soady has been appointed manager of the Contract Section of the Railway Department, of the **Westinghouse Electric & Manufacturing Company** to succeed Mr. Long.

The Nathan Manufacturing Company has removed its Chicago office from 707 Great Northern building to 14 East Jackson Boulevard.

Oliver W. Loomis, manager of sales of the **National Malleable Casting Company**, Cleveland, Ohio, has been appointed manager of the company's malleable plants at Chicago with his headquarters at 2610 West Twenty-fifth place. **O. J. Fehling resigned. James A. Slater**, assistant manager of sales with headquarters at Cleveland, Ohio, to succeed Mr. Loomis as manager of sales.

Robert Huff, representative of the **McConway & Torley Company**, Pittsburgh, Pa., has removed his office from 39 Cortlandt street, N. Y., to 2 Rector street, New York City.

W. E. Brewster, advertising manager of the **U. S. Light & Heat Corporation**, Niagara Falls, has resigned and **E. D. Giauque**, who has been Mr. Brewster's assistant, has been appointed to succeed him as advertising manager.

H. B. Doerr, chief mechanical engineer of the **Scullin Steel Company** with headquarters at St. Louis, Mo., has been promoted to general superintendent succeeding **L. C. Perry**, who resigned to engage in private business.

Joseph T. Ryerson & Son, Inc., has moved its office from 6 No. Michigan avenue, Chicago, to 2443 Sheffield avenue, Chicago, Ill.

Locomotive Lubricator Company has removed its office address from 6 No. Michigan avenue, Chicago, Ill., to its new shop 2443 Sheffield avenue, Chicago, Ill.

P. B. McGinnis has been appointed representative of the **Westinghouse Air Brake Company** with headquarters at Chicago, where he previously served as Mechanical Expert. **H. R. Wood**, of the Wilmerding organization, succeeds him as Mechanical Expert.

W. W. Martin, of the general offices of the **Westinghouse Air Brake Company** at Wilmerding, Pa., has been elected an assistant auditor of the company. Mr. Martin has been connected with the Air Brake auditing department since 1906 and was chief clerk prior to his recent promotion.

The Edgewater Steel Company has removed its offices from 316 McCormick building to 1335 People Gas building, Chicago, Ill.

The Palmyra Packing Company has been incorporated in New York, with general offices and factories at Palmyra, N. Y., to manufacture a complete line of asbestos, flax, rubber and duck packings for locomotives and shop machinery. The offices of the company are **John N. Todd**, president, formerly general sales manager of the Garlock Packing Company; **Frank W. Coats**, vice-president formerly vice-president of the Crandall Packing Company; **Samuel H. Hunt**, treasurer, a capitalist of Palmyra, N. Y., and **Charles McLouth**, secretary, an attorney of Rochester, N. Y.

Items of Personal Interest

T. B. Tarrington, master mechanic of the Pennsylvania with headquarters at Columbus, Ohio, has been appointed assistant works manager of the Altoona shops at Altoona, Pa.

S. B. Andrews has been appointed mechanical engineer of the Chesapeake & Ohio with headquarters at Richmond, Va.

W. R. Davis, assistant master mechanic of the Pennsylvania with headquarters at Wilmington, Del., has been promoted to master mechanic with headquarters at Indianapolis, Ind.

A. C. Davis, superintendent of motive power, Southern Division of the Pennsylvania, with headquarters at Wilmington, Del., has been appointed assistant chief of motive power with headquarters at Philadelphia, Pa.

Harry E. Baily has been appointed superintendent of New York division of the New York, New Haven & Hartford Railroad Company, with headquarters at Harlem River, New York, succeeding **F. M. Clark**, who has been granted a leave of absence because of illness.

H. W. Ridgway, superintendent of motive power of the Colorado & Southern, has been appointed assistant to the superintendents of motive power on Chicago, Burlington & Quincy lines west, with headquarters at Denver, Colo.

G. Durham, recently appointed superintendent of motive power of the Wheeling & Lake Erie with headquarters at Cleveland, has been appointed acting general manager, with same headquarters, relieving S. Ennes, president and general manager who has given up the duties of general manager on account of ill health.

F. R. Butts, general foreman on the Chicago, Burlington & Quincy, has been promoted to assistant master mechanic of the Beardstown division with headquarters at Centralia, Ill.

W. J. Tollerton, general mechanical superintendent of Chicago, Rock Island & Pacific, with headquarters in Chicago, has been given the title of general superintendent of motive power.

J. F. Long, master mechanic of the Baltimore & Ohio, with headquarters at Connellsville, Pa., has been appointed superintendent of motive power of the Los Angeles and Salt Lake with headquarters at Los Angeles, Calif.

H. H. Maxfield, general superintendent of motive power of the Central region of the Pennsylvania, has been appointed superintendent of motive power of the Southern division with headquarters at Wilmington, Del.

F. W. Hankins, assistant chief of motive power of the Pennsylvania with headquarters at Philadelphia, Pa., has been appointed general superintendent of motive power of the Central region with headquarters at Pittsburgh, Pa.

R. H. Flynn, master mechanic of the Pennsylvania with headquarters at Indianapolis, has been transferred to Columbus, Ohio.

Charles Quantic has been appointed superintendent of motive power and car equipment of the Canadian National Railways with headquarters at Vancouver, B. C. He formerly was master mechanic of the Canadian National Railways with headquarters at Vancouver, B. C.

O. E. Ward, assistant master mechanic of the Galesburg division of the Chicago, Burlington & Quincy with headquarters at Galesburg, Ill., has been promoted to master mechanic of Alliance division with headquarters at Alliance, Nebr.

H. H. Urbach, general foreman, has been promoted to assistant master mechanic of Galesburg division with headquarters at Galesburg, Ill., succeeding Mr. Ward.

W. M. Whitenton has been elected vice-president in charge of operation of the Missouri, Kansas, Texas, with headquarters at St. Louis, Mo.

T. C. Hudson has been appointed assistant general superintendent of motive power, central region of the Canadian National Railways with headquarters at Toronto, was formerly master mechanic of the Canadian National Railways with headquarters at Montreal.

W. G. Horne, Jr., has been appointed general roundhouse foreman of the Southern Railway with headquarters at Alexandria, La. Mr. Horne was formerly general foreman at Selma, N. C.

I. A. Macpherson, division superintendent on the Canadian National with headquarters at Melville, Sask., has been transferred to the Regina division, with headquarters at Regina, Sask.

Obituary

George Jay Gould, long a conspicuous figure in American railroad direction and finance, died on Wednesday, May 16th, at Mentone, France, at the age of 59 years. Mr. Gould was born in New York, February 6, 1864. He was the son of Jay Gould the famous railroad financier.

In 1888 he entered railroad service as president of the Little Rock & Ft. Smith Ry. Co., was president of Manhattan Railway from 1888 to 1913, first vice-president of the Texas & Pacific Railway from 1888 to 1893 and president until 1913, also president of the Missouri Pacific Railway from 1893 to 1911 and chairman of the board until 1917.

He was also at various times president and director of several minor railroads.

Prof. Dr. Hans Goldschmidt, inventor of the Thermit process, died suddenly after a stroke on May 20th, in Baden-Baden, Germany. Prof. Goldschmidt was born in Berlin, Germany, on January 18, 1861. He received his degree of Ph. D. from the University of Heidelberg in 1886.

Prof. Goldschmidt's most important invention was the Thermit process now used all over the world for welding iron and steel and for producing metals and alloys of high purity.

Prof. Goldschmidt was president of the Goldschmidt Thermit Company from 1904 to 1916. This company is known now as Metal Thermit Corporation, 120 Broadway, New York, N. Y.

Frederick A. Guild, who retired several years ago as the New York representative of the Galena Signal Oil Company, died at his home Greens Farms, Conn., on May 14th, in his 77th year.

J. M. Egan, formerly president of the Kansas City Terminal and of the Central of Georgia, died at his home, Amboy, Ill., on May 9th in his 75th year.

Scott R. Hayes, vice-president of the New York Air Brake Company, died on May 6th at Ossining, New York. He was a son of former President Rutherford B. Hayes.

Books, Catalogues, Etc.

Highways and Highway Transportation, by George R. Chatburn, Professor of Applied Mechanics at the University of Nebraska, Thomas Y. Crowell Co., New York, 472 pages, 5¼ inches by 7¾ inches. Cloth.

Sir Isaac Newton once said that the movement of a grain of sand upon the seashore made a change in the center of gravity of the universe. Likewise, it has been averred that the conduct of each individual on earth affects the welfare of every other individual. Of course, these influences are slight, even supermiscroscopic, but they probably exist. So in the book before us, the author evidently had in view the effect of remote causes on immediate surroundings, the immediate surroundings being the highway. A recollection of the reading of the book leaves the impression of an interesting sort of pot pourri, a mass of information, well written and well put but without much of a logical sequence.

The book starts out with the thesis that transportation facilities are a measure of civilization, and then traces the development of the trail to the modern highway. But in going so he writes of the pastoral and agricultural stages of human progress, of the manorial and feudal systems of Europe and the craft guilds with their influence on trade, through to the development of power-driven machinery and the introduction of railways. Then he drops back to the old Roman roads, talks of their value to the state and follows with a few paragraphs on the pre-historic roads of America.

There is a long chapter on transportation development in the United States, starting with the birch bark canoe, giving much of detail as to the blazing of Boone's trail across the Alleghenies, and a brief description of the trunk roads across the continent to the West. There is a brief review of the Lewis and Clark expedition to Oregon. The dealing with the transcontinental trails is very brief and leaves the reader with but scant information regarding them. In this chapter he brings up the turnpike and in the very next paragraph speaks of wagon road desuetude because of the introduction of the railway and then straightway brings up national participation in road building and the great Cumberland highway.

There is a chapter on waterways and canals with a rather full exposition of the political history of the Panama Canal and the development of the river boat with some account of the fast time made on the Mississippi, with the rates of fare on several water routes, closing with a few pages on the attitude of the government toward river and harbor improvements. Then comes a chapter on railroads, with illustrations of the early locomotives and stories of inconveniences; the development of the sleeping car, and even of the mythical speed of No. 999. He discourses on government ownership, and says that the fact that it (the government) has made a success of the construction and operation of the Panama Canal leads many to believe that the railroad question would have been handled as easily if that system had grown up from the beginning, apparently overlooking his own statement that the total annual revenue of the canal amounts to only a little more than 1½ per cent of its cost, certainly not an attractive investment.

It is difficult to say what the sequence of the book is. In his chapter on the modern wagon road he jumps from the decay of the road on the advent of the railway to the influence of the bicycle; he quotes doggerel rhymes and no end of endorsements of the desirability of good roads by senators and congressmen. He discourses on rural free delivery, state and federal aid, and quotes abstracts from the law of several states.

He glorifies the automobile, and branches off into its use by robbers and the vandalism of the ordinary driver, and even notes that "spooning in automobiles parked along the roadways is a subject of regulation in the city of Omaha."

In the planning of highway systems, he gives some very definite instructions as to preliminary work and the methods of taking a road census, but when he comes to the discussion of the several kinds of roads to be laid, he simply lists them, gives their several advantages or disadvantages, but leaves the reader quite uninformed as to the details of construction.

As to the effect of ease of transportation he shows how good roads have contributed to motor truck deliveries to the stock yards, and how it can be used in logging operations. There are chapters on highway accidents and highway esthetics. In the former he gives some figures that convey but a faint idea of the recklessness of the average automobile driver even through crediting the whole with killing over 12,500 people annually. In the chapter on esthetics he devotes 34 pages to the listing of 136 varieties of trees that may be used for decorating highways.

The closing chapter is on aids and attractions to traffic and travel, and contains numerous illustrations of sign boards and recommendations as to terminal stations and other conveniences. The final pages of the book are devoted to an index.

Taken as a whole, the book is well worth while, despite the large amount of seemingly irrelevant matter that it contains. It leads one to think that the author had collected a vast amount of information directly and remotely connected with highways and that he wanted to use it all.

Thermal Stresses in Steel Car Wheels. An investigation of stresses induced in steel car wheels from heating the tread has been carried out at the Bureau of Standards in a manner approximating severe service conditions. It is said by experienced railway men that the tread of the wheel becomes heated to a dull red from the application of brake shoes on descending long mountainous grades. A large number of rolled, forged and cast steel wheels both new and worn were tested. In the tests the wheels were mounted on a hollow water cooled axle and the treads were heated by passing an electric current through a soft steel resistor which encircled the wheels.

Observations were made every ten minutes during the test of the temperatures and deformations throughout the wheel. In the regular tests the maximum tread temperature reached 716° F. in 90 minutes, and in three special tests the tread was heated to about 500° C. in 150 minutes. Although the test was more severe than actual service conditions, none of the wheels developed cracked plates in any of the tests.

The results of the investigation show the manufacturers how the wheels are deformed from high tread temperature, giving the magnitude and distribution of stresses throughout the wheels. The manufacturers will be able to use these new data to advantage in considering the question of proposed changes of design and manufacturing practice.

They are contained in Technological Paper No. 235 of the Bureau of Standards, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Landis Threading Machinery catalog No. 26 of the Landis Machine Company Incorporated, Waynesboro, Pa., has just been issued. It describes in detail this celebrated line of threading machines, pipe and nipple threading machines, pipe threading and cutting machines, chaser grinder and automatic die heads. The catalog has been carefully prepared, contains 80 pages and should be in the hands of all interested in threading or cutting machinery.

The Railway & Locomotive Historical Society, Bulletin No. 5. This is the fifth bulletin to be presented to members and those interested in the work of this society. The pamphlet contains 69 pages, is excellently printed and contains about 24 illustrations of the early locomotives. The subjects of the various articles in this bulletin are as follows:

The Early Railroads of Kentucky by Charles E. Fisher; Railroads of the West by D. L. Joslyn; Some Anecdotes of the Old Colony by Warren Jacobs; Transportation by James M. Kimball; The Locomotive Commonwealth of the B. & M. P. Railroad by Weston Holm; Some notes upon Early English Locomotives in America by D. W. Bishop. The pamphlet also contains a brief account of the celebration of the 100th anniversary of the Delaware & Hudson Company and also some notes in regard to early locomotive and railway history, that should be of real interest to those interested in the early history of locomotive and transportation, generally.

Little Railroads With Big Dividends

Although it is one of the shortest lines in Venezuela (22 miles), the La Guaira and Caracas Railroad, which has been in operation since 1883, is considered the most important and best in the Republic, according to the Transportation Divison of the Department of Commerce. It operates in the Federal District, connecting the capital of the country with the principal seaport, about 2½ hours being required to traverse its entire length. In crossing the Coast Range to reach Caracas the road climbs from sea level at La Guaira to a pass about 3,000 feet in altitude. Because of its route along the mountain side the line appears dangerous, but it is so well constructed and so closely inspected that accidents are rare, none involving loss of life having occurred in the history of the line.

Notwithstanding the competition offered by the Caracas-LaGuaira Highway with its mule carts, pack animals, and automobiles, the La Guaira-Caracas Railroad carries approximately one-fourth of the railroad freight of the country.

Traffic statistics for the year ended December 31, 1920, are as follows:

Freight carried, metric tons	91,971
Passengers carried	92,401
Gross revenue, Bolivars	3,549,058
Freight revenue, Bolivars	2,860,100
Passenger revenue, Bolivars	688,958
Operating expenses	1,895,386
Net gain	1,653,672

The railroad is one of the most prosperous in Venezuela. In late years a dividend of 6 per cent has been paid regularly on capital shares. Dividend rates on ordinary shares for 1910 to 1920, inclusive, were 5½, 7, 8, 8, 8, 6, 6, 6, 6, 7, and 8, including a bonus of 1 per cent.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXVI 114 Liberty Street, New York, July, 1923 No. 7

The M. & L. Booster on the Delaware & Hudson

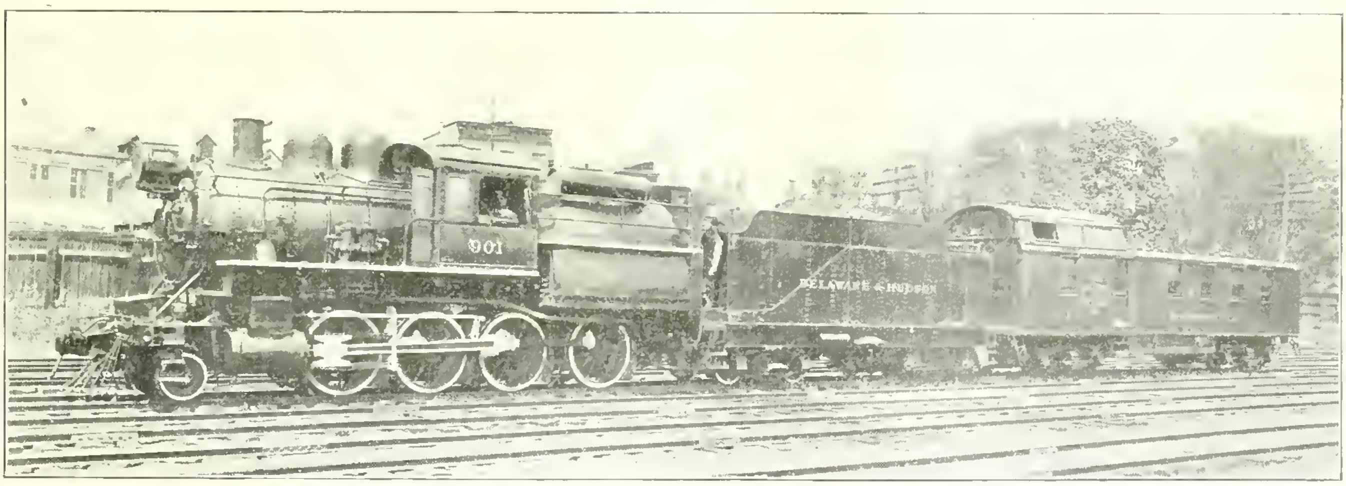
Successful Demonstration of the Efficiency of a New Locomotive Booster

As noted in the June issue of this paper a successful demonstration of the effectiveness of a new locomotive booster was made on the lines of the Delaware & Hudson on the morning of June 5. A special train leaving Albany at 8 A. M. carried about 65 guests and officers of the railway to Schoharie Junction about 35 miles from Albany on the Susquehanna Division. This was at the foot of a grade known as the Esperance Hill, about six miles long that averages about .8 per cent. compensated with a range from .13 to 1.16 per cent. It was in hauling a train up this grade towards Albany that the demonstration was made.

The guests were carried on three flat cars that had been provided with protecting railings. This train was hauled on a track paralleling the one upon which the demonstration was being made, and by making slight variations in the speed the flat cars were moved slowly to and fro opposite the booster so that everyone could have an opportunity of witnessing its action. This arrangement is clearly illustrated by the accompanying engraving.

The booster was attached to the rear truck of the tender of a consolidation locomotive No. 901, which is shown in the frontispiece illustration attached to dynamometer car. The following are the general dimensions of the locomotive:

Diameter cylinders	21½	inches
Piston stroke	30	"
Diameter driving wheels	57	"
No. tubes	210	
No. super heater flues	30	
Diameter tubes	2	inches
Diameter flues	5⅜	"
Length of tubes and flues	14	feet
Height of stack above rails	15	feet
Tank capacity, water	9,000	gallons
Tank capacity, coal	14	tons
Weight on truck	24,000	pounds
" on drivers	183,150	"
Total	207,150	"
Weight on tender (light)	88,400	pounds
" tender (loaded)	157,067	"
" engine and tender	364,217	"
Tractive power	42,100	"
Steam pressure	200	"
Heating Surface—		
Tubes and flues	2,116	sq. ft.
Firebox	227	" "
Total	2,343	" "



Locomotive Equipped with M. & L. Booster with Dynamometer Car Attached

Equivalent	3,049	" "
Superheater	471	" "
Grate area	90.06	" "
Firebox, length	120⅛	inches
Firebox, width	108	"
Frames, center to center	43	"
Cylinders, center to center	86	"
Valve travel	5½	"
Valve lap	⅞	"
Valve exhaust clearance	⅛	"
Valve motion		Stephenson
Kind of fuel		Anthracite
Engine wheel base	25 ft.	5 in.
Driving wheel base	17 "	0 "
Tender wheel base	23 "	5½ "
Front tender truck wheel base	6 "	0 "
Tractor tender truck wheel base	6 "	8 "
Total wheel base, engine and tender	59 "	8 "
Total length of engine & tender over all	69 "	0¾ "

$$\frac{\text{Total equivalent heating surface}}{\text{Grate area}} \quad 33.86$$

$$\frac{\text{Rated tractive power}}{\text{Evaporative heating surface}} \quad 17.97$$

$$\frac{\text{Weight on drivers}}{\text{Tractive power}} \quad 4.35$$

$$\frac{\text{Total evaporative heating surface}}{\text{Cylinder volume}} \quad 185.95$$

$$\frac{\text{Firebox heating surface}}{\text{Total evaporative heating surface}} \quad 9.69$$

$$\frac{\text{Firebox heating surface}}{\text{Grate area}} \quad 2.52$$

$$\frac{\text{Grate area}}{\text{Cylinder volume}} \quad 7.15$$

$$\frac{\text{Total evaporative heating surface}}{\text{Grate area}} \quad 26.02$$

In the calculation of the "equivalent" heating surface in the above table the evaporative heating surface is given an equivalent foot for foot, and a square foot of superheater heating surface is taken as equivalent to 1½ feet; so that the 471 sq. ft. of superheater surface are equivalent to 706 sq. ft.

The A rating of the locomotive is 1,885 adjusted tons. The test rating in the demonstration train was 2,476 adjusted tons, or an increase of 591 tons, or 31.35 per cent above the A rating. The total number of cars in the train was 36, all of which were loaded, and weighed 2,260 tons.

In working out the adjusted tonnage for this train, 6 tons were allowed for each loaded car, and as the whole 36 were loaded this added 216 tons to the actual weight, bringing the adjusted tonnage up to 2,476 tons.

In addition to the loaded coal cars, the Delaware & Hudson dynamometer car was coupled in immediately back of the locomotive, and with it the drawbar pull back of the tender was recorded for the whole of the run.

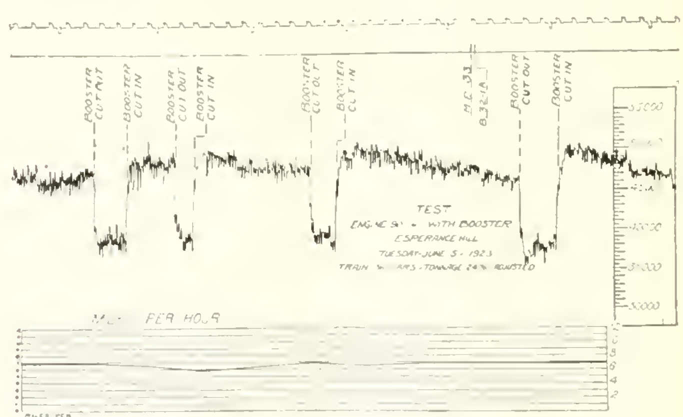
The train was started by the locomotive without the assistance of the booster, but the latter was thrown into action almost immediately.

Frequently during the run the booster would be thrown out of action for a few moments at a time, and then brought back into service again. This was done in order to show the visitors the ease with which such an action could be accomplished.

Every change of this kind was immediately manifested on the dynamometer records, two examples of which are shown in the accompanying engravings.

Observation Train Running Beside Demonstration Train of M. & L. Booster

In these diagrams the top line indicates the time interval, each notch on the upper side indicating 10 seconds and on the lower 1 minute. Mile-posts are shown by the second line. The drawbar pull by the next. The speed in miles per hour, with the alignment and grade completes the diagram.



Dynamometer Record of Test of M. & L. Booster, Showing Effect of Booster In and Out of Action

Whenever the booster was cut out the drop in tractive effort is very marked and immediate, while in connection with it there was an immediate falling off in the speed of the train. With the booster in action the speed was held steadily at about 7 miles an hour, but, when the booster was cut out it fell to about 6¼ miles per hour in about 16 seconds and was still falling when the booster was again cut in.

This statement is made in connection with the principal diagram where this loss of ¾ mile per hour in speed was sustained in 16 seconds after the booster had been cut out.

The speed then slowly increased to about 6½ miles per hour in about 55 seconds. After which for some reason the rate of acceleration was more rapid, and 2 minutes 21 seconds after the booster had been cut in it had risen to about 7½ miles per hour.

As for the tractive effort, immediately before cutting out the booster it was 45,000 lbs., dropping to 38,000 lbs. without the booster, to rise again to about 48,500 lbs. as soon as it was cut in, and then falling away a little as the speed rose.

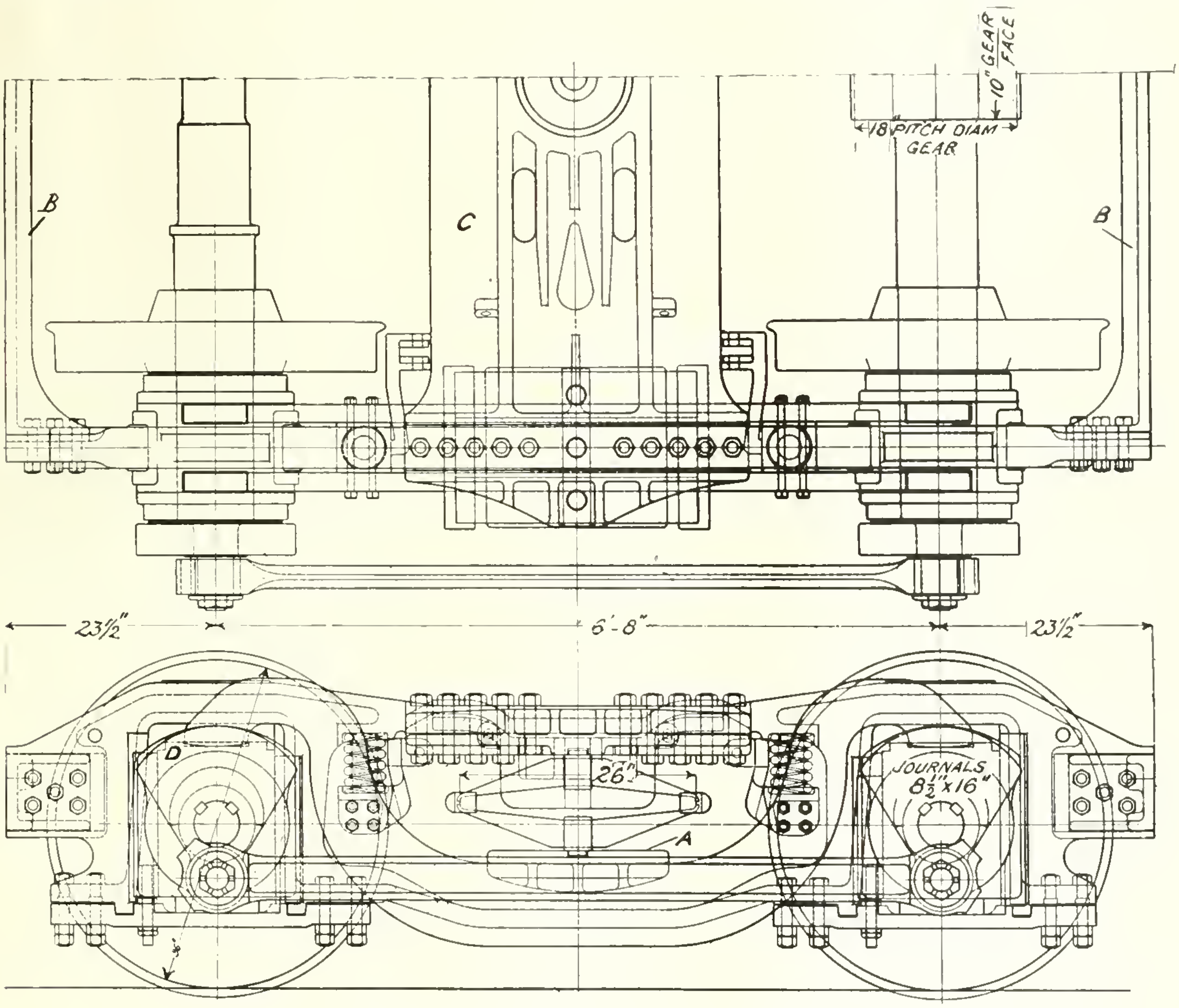
At the point indicated as a stop a demonstration was made of the value of the booster in assisting to start a heavy train.

The diagram shows that the booster was first cut out, and then the engine was shut off, followed straightway by a drop of the tractive effort to zero, while the train drifted to a stop in about 30 seconds.

This stop was made about ¼ mile before reaching mile post 30, where the grade was one of 0.9 per cent. About a half dozen attempts were then made to start the train with the locomotive alone. The slack was taken up by bunching the train and the engine started. In every case the engine was started before the caboose was moved. Having thus shown that the engine alone was quite incapable of starting the train on that grade, the booster was thrown into action, when the start was made with no apparent difficulty, and the speed raised to about 4½ miles an hour in about 70 seconds, and then because of a change in the point of cut-off of the engine. The speed then rose more slowly to 7 miles an hour in 60 seconds, or at the rate of about .04 mile per second.

After the train had been accelerated to about 7½ miles per hour, the demonstration was considered to be at an end and the visitors' train pulled away and left the demonstration train to finish the run without observers.

The net result of this was to show that the booster can be thrown in and out of service with perfect facility and without producing any jar or pound that could be detected by observers within 6 ft. of the track upon which the booster was operating, and that there was immediate evidence of its effectiveness in the rise of the drawbar pull. And further, that the increase of tractive effort brought about by the use of the booster varied from 25 to nearly 35 per cent of that of the locomotive working alone.

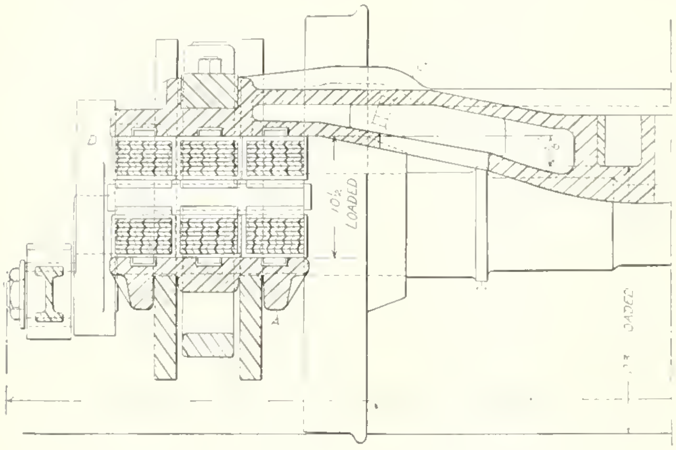


Tender Truck to Which Booster Engine Was Fitted

We have seen that the theoretical tractive effort of the engine is placed at 42,100 lbs. The calculated tractive effort of the booster in 14,400 lbs., or 34.2 per cent of that of the locomotive. In this demonstration this ratio was held in actual service.

As already stated this booster is applied to the rear truck of the tender. This truck is of the side equalizer type, similar to those used in passenger car equipment, with certain modifications. These modifications are that the equalizer springs instead of being helical, consist of two elliptic springs which set upon a cast steel bed A, that rests upon the two equalizers at their center. These springs carry the truck frame, which is of cast steel. As the booster engine occupies all of the space between the wheels and the axles, there is no room for a spring plank or cross ties below the upper portion of the frame.

The side frames are each cast with the pedestal legs, and are tied together by the two end pieces *BB* and the center piece or transom *C*. These end pieces are bolted in place by five $1\frac{1}{8}$-in. finished bolts, and the transom by ten $1\frac{1}{4}$-in. bolts all, both for end pieces and transoms, being driven into reamed holes. The center plate is cast solid with the transom, which is so designed as to be



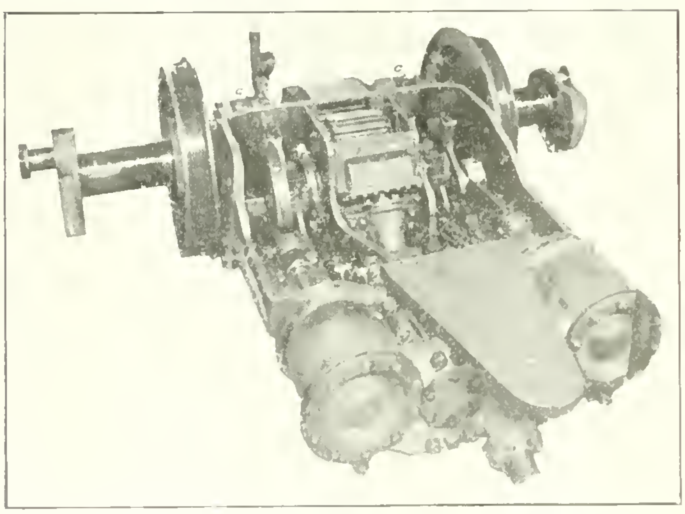
Half Section at Center of Booster Engine Truck

capable of carrying a load of 100,000 lbs. on the center plate.

The pedestals are braced with tie bars, that are fitted and held in the same manner as the tie bars of a locomotive driver pedestal.

And the pedestal itself is fitted with shoes and wedges in the same way as are the driver pedestals of a locomotive.

The journal boxes are also of the same type as those



M. & L. Booster with Driving Axle and Wheels

used for locomotive driver axles, but they are, however, placed outside of the wheels instead of between them.

The axles are fitted with journals $8\frac{1}{2}$ in. in diameter and 16 in. long. The end of the axle is turned down to a diameter of 5 in. to form a seat for the crank which is keyed in place with two $1\frac{1}{4}$-in. by 1 in. keys set at an angle of 90 degrees with each other and central with the line of the crank itself. The crank and counter balance are cast in one piece, the latter being hollow and filled with lead in order to save space. The crankpin bearing is 4 in. in diameter and $4\frac{5}{8}$ in. long.

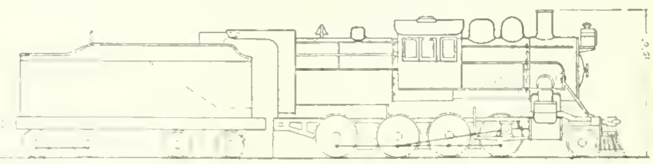
As the drive is at the center of one axle the use of side rods with cranks set at right angles is necessary.

The truck frame proper is not connected in any way with the booster engine, which rests upon the two axles, between the frames.

The front axle or the one towards the center of the tender is the driving axle, and it is to the center of this axle, on a raised seat $9\frac{1}{2}$ in. in diameter, that the gear is keyed. This gear has a pitch diameter of 18 in., a face of 10 in., and has 36 teeth, with a ratio of $2\frac{1}{4}$ to 1 with the pinion on the engine shaft, giving the latter 16 teeth. The circumferential pitch of this and pinion is 1.57 in. The body of the axle between the gear and the wheels has a diameter of 9 in.

The construction of the engine is shown in considerable detail by the half plan and the three longitudinal and cross sections.

The engine frame is formed of one casting, an idea of whose general shape can be better understood from the reproduction of the photograph of the engine, than from the line drawings alone. By a comparison of the two it will be seen that this frame consists of a steel casting flat at each end, as indicated at *EE*, while the vertical ribs *FFFF* connect the two ends and serve to give the whole frame great vertical stiffness. At the rear end of the frame the bearing plate or tongue *I* is cast. This extends back and serves as the point of support on the rear axle, thus effecting a three point support. There is a bottom extending the full width of the two side pockets so that



Outline of Consolidation Locomotive Fitted with M. & L. Booster

there is no access to the machinery contained therein from below. This bottom has an opening in the central pocket for the admission of the steam and exhaust pipes. This is at the rear end near the cylinder casting, and beneath the engine shaft there is a covered opening measuring 4 in. by $8\frac{1}{2}$ in. and set with the inner edge $2\frac{1}{4}$ in. from the center. It is through these that access is obtained to the pinion on the engine shaft, and the lever carrying the idler pinion.

To the front end of the frame the upper half of the journal boxes *G* are cast. The upper portion is first fitted to the axle and then, after the motor has been placed upon the axle, the lower part is bolted to it and to the frame. The upper portions contain the two journal bearings that rest upon the axle. Between them there is a cast hood that reaches over the gear. At the bottom the opening is closed and the gear protected by a covering of plate metal. There are two of these journal boxes, one setting on each side of the gear, the bottom portion, containing the oil and waste cavity, is fitted with an ordinary journal box cover, which can be raised for repacking and lubrication. Each part is lined with a half bushing of brass as a bearing.

The lubrication is effected in the same way as for an ordinary car journal, but because of the lesser weight carried, the waste is not carried across the full width of the axle, but touches it only through an opening *H*, which is $4\frac{1}{4}$ in. wide. These form the two steadying supports for the motor. The cylinders are of cast iron and, with the steam chests, are bolted to the front end of the frame, beneath the supporting tongue *I*.

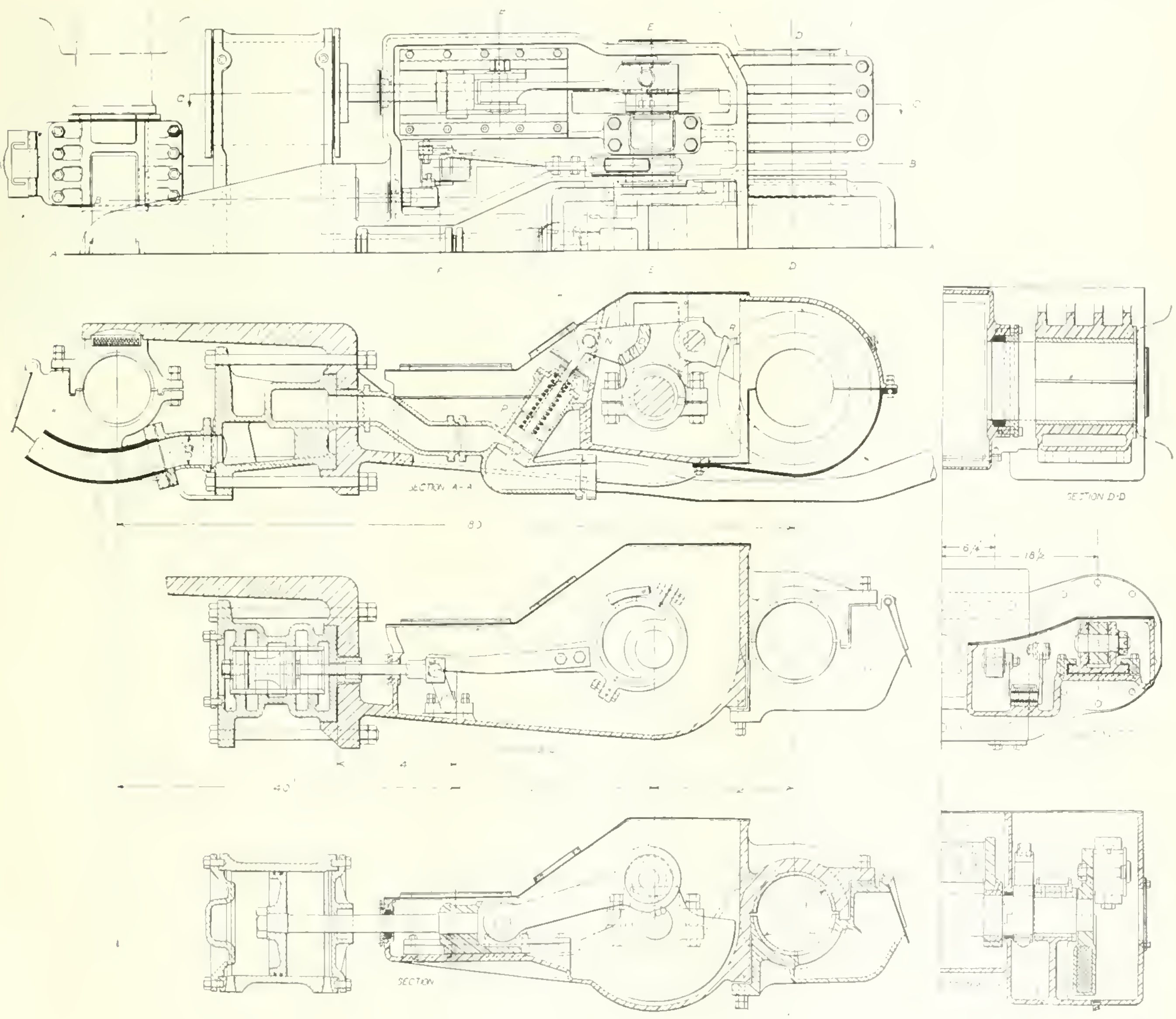
The cylinders have a diameter of 12 in. with a piston stroke of 12 in. The connecting rod is only 18 in. long between centers, making the rather small ratio of $1\frac{1}{2}$ to one between it and the stroke. The piston rod is 2 in. in diameter.

As the booster is to be operated only when the locomotive is moving forward and then at its maximum capacity, a single eccentric giving a fixed cut off is used for operating the valve. This eccentric has a throw of 4⅛ in. and the piston valve is 4½ in. in diameter, it has a travel of 3¼ in. This, with a lap of ⅞ in., and a lead of 1/32 in., produces a cut-off at 70 per cent of the stroke. When the locomotive is running at a speed of 7 miles per hour the booster engine is making about 135 revolutions per minute.

Steam is conveyed to the booster through a 3-in. pipe and, from it, the exhaust pipe is 3½ in. in diameter. The couplings between the locomotive and tender are made with the Barco joints. At the rear the exhaust passes up through the water space of the tender with its discharge just ahead of the back sheet of the tank. This is accomplished by inserting a 10-in. pipe extending from the top to the bottom sheet of the tank. At the lower end and beneath the floor of the tender, a funnel-shaped flare is attached. It is into this funnel that the exhaust is discharged, and without the exhaust pipe having any physical connection therewith. The clearance of the funnel about the 3½-in. exhaust pipe is sufficient so that the engine can move over any of the curves on the road without the two coming in contact.

The tongue *I* of the frame is supported on a leaf spring made of three plates of ¼ in. by 5¼ in. steel. This spring spans the space between two axle boxes which are shown in side elevation and in plan at *K*. They are set on the rear axle on each side of the center line and are kept in place by collars *M* on the axle.

They stand 11 in. apart, and are of the same general character as the boxes at the forward axle. They are in two parts, with the lower portion containing the oil and waste cavity bolted on, and the whole lined with a brass bushing, as shown in connection with the other box.



Plan and Sections of M. & L. Booster

The connection between the pinion on the engine shaft and the gear on the axle is made by means of an idler pinion which is carried on a cast steel bell-crank lever *N*. This lever is forked-shaped in plan, and the two prongs of the fork straddle the idler pinion. A shaft 2½ in. in diameter passes through these prongs and is keyed rigidly in them and, on it, the idler runs loose. The two prongs are tied together by a cross tie *O*, cast integrally with them. The ends toward the engine have bosses through which a shaft passes, to which the end of the piston from the clutch cylinder P is attached. This connection is made by a slotted hole in the end of the piston rod, so as to allow it to move in a straight line, and yet permit of the necessary angularity of movement of the bell-crank.

The third point of the bell-crank is pivoted on the engine shaft and the idler shaft is thus held at the constant distance of 8 in. from the engine shaft so that the two pinions are always in mesh.

The idler is thrown into mesh with the gear on the axle, by admitting a steam pressure beneath the piston in the cylinder P. This compresses the spring by which the piston is held to the lower end of its stroke. As the piston rises it turns the bell-crank and throws the idler over and into mesh with the gear.

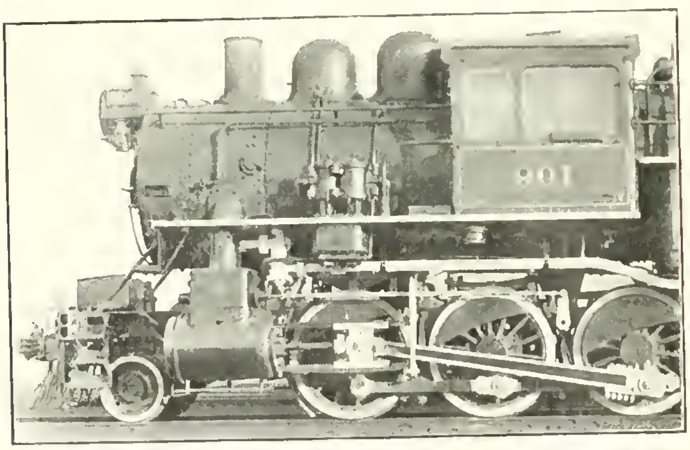
In order to prevent too great a movement and causing the teeth to bottom a stop wedge R is attached to the frame casting. This is so adjusted that when the heel of the bell-crank comes into contact with it, the pitch lines of the idler and the gear are tangent to each other and the two are exactly in mesh.

The clutch cylinder P has a diameter of 4 in. and the spring is set with a tension of 700 lbs. so that a steam pressure of a little more than 55 lbs. per sq. in. must be developed before the piston will move to throw in the idler.

It will be seen that the steam pipe opens to this cylinder. So that when the booster throttle is opened on the locomotive the steam flowing through the steam pipe throws the idler into mesh with the gear and starts the booster engine almost simultaneously.

From the engine the booster takes its steam from the left hand outside steam pipe, as shown by the illustration, so that there is no possibility of the booster engine starting unless the locomotive throttle is open.

In order to prevent the possibility of the engineman cracking the booster throttle and admitting enough steam to start its engine, and yet not developing enough pressure beneath the clutch piston to compress its spring, a special form of throttle is used. It is located just back of the outside steam pipe on the left hand side, and is operated



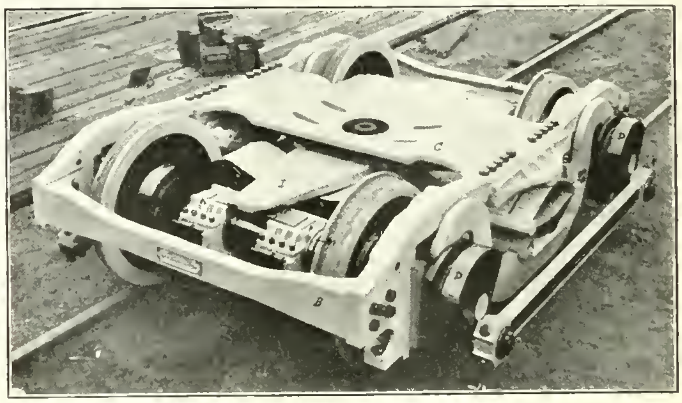
Front of Engine Fitted with M. & L. Booster Showing Attachment of Throttle Valve

by air pressure, admitted to it by means of a New York straight air engineer's valve in the cab. When this valve is opened, though it be ever so little, the booster throttle goes to a wide open position, if it moves at all; so that the movement of the idler into mesh with the gear is always assured.

The lubrication of the engine is effected by a splash system. The space beneath the shaft is filled with oil up to a level with the guides. Cups are attached to the cranks and to the connecting rods by which the oil is thrown over the working parts. In the case of the connecting rod, a hole leads from the bottom of the cup to the crank pin, so that as it scoops into the oil the latter is forced back through this hole to the pin, which it effectively lubricates.

The total weight of the booster alone, as it rests on the axles, is placed at 6,610 lbs., which is evenly divided between the two axles.

As the driving axle is the leading one with reference to the booster, it rotates in the direction of the arrow,



M. & L. Booster and Truck Complete

when the engine is moving ahead, which means that there is an upward thrust against the teeth of the pinion with a corresponding downward one on the engine frame. It is estimated that this thrust on the gear amounts to 29,690 lbs. This it at a point 9 in. from the forward axle. As the wheelbase is 80 in. it means that of this 29,690 lbs. about 3,340 lbs. is transferred back to be carried by the tongue and the balance by the main journals.

These journals are 9 in. in diameter and 12 in. long, so that their total projected area is 216 sq. in. They are thus burdened with a load of 29,595 lbs., or only 137 lbs. per sq. in. of projected area when the booster is at work.

As to steam consumption, the steam gauge on the locomotive was in full view of the observers during the whole of the demonstration run and stood steadily at a little above 200 lbs., showing that the demands, at that time, at least, were within the capacity of the boiler.

It has been found that a full steam pressure with a superheat to 610° Fahr., can be maintained at the booster engine, when both it and the locomotive are working to capacity.

The clearance spaces of the booster cylinder amount to 13 per cent of the stroke. If we assume a speed of 7 miles per hour, with a booster rate of revolution of 135 per minute, steam at 200 lbs. pressure and 610° of superheated temperature, and a cut-off at 70 per cent of the stroke, we can calculate the steam consumption of the booster as follows:

The steam will weigh .3436 lbs. per cubic foot. The engine will take in 938.71 cubic inches per stroke and at 135 strokes per minute the consumption will be about 6,000 lbs. per hour. The tractive effort at the rail will be 14,400 lbs., or about 532,000,000 ft. lbs. of work per hour.

In reviewing the general features of this booster, it will be seen to possess the desirable ones of simplicity and accessibility. The simplicity of its construction will be appreciated from the foregoing description.

As to accessibility, it is pretty well shut in when in place. But by jacking up the tender and running out the truck all parts are at once readily accessible.

It is the intention to have one type of booster on one type of truck to be used on all engines, so that in case of a failure, it will only be necessary to raise the tender, break one joint in the steam pipe, run a fresh truck under, recouple the pipe and lower the tender in place. It is estimated that with the ordinary run of work as it is done in the roundhouse, this transfer could be accomplished in an hour, and the engine be ready for service. In other words, the booster can be replaced in less time than that usually occupied by the roundhouse forces in making an engine ready for a run.

Proceedings of the A. R. A. Mechanical Convention

Successful Three Day Session a Thoroughly Business Meeting

By W. E. SYMONS

The annual meeting of the Mechanical Division, American Railway Association was held in Orchestra Hall, 220 South Michigan Ave., Chicago, Ill., June 20-21 and 22.

There were no exhibits or social features, hence it was strictly a business session commencing at 9.30 A. M. with the usual noon luncheon hour of business men, the afternoon sessions closing about 5 P. M.

The acoustic properties of the hall are bad; it was poorly ventilated, and the weather was miserably hot, all of which added much to the annoyance and discomfort of those in attendance of whom there were about 600.

The proceedings of the Chicago convention comprised a number of addresses, several individual papers, committee reports and discussion of these papers and reports, as well as a discussion of the special topics arranged for on the program. The discussions on committee reports and special subjects constituting one of the most valuable features of the convention.

The opening address on June 20 was delivered by the chairman, J. Coleman, general superintendent car equipment, Canadian National Railways. Mr. Coleman then read messages from General W. W. Atterbury, operating vice president, Pennsylvania System, and Sir Henry Thornton, K. B. E., president, Canadian National Railways, who were unable to be present and address the convention.

Each of these gentlemen covered the railway situation in a most comprehensive manner and pointed out in what manner the desired ends could be attained.

R. H. Aishton's Address

As President of the American Railway Association, of which the Mechanical Division is an integral part it seemed fitting and proper that Mr. Aishton should address the convention on questions of achievement and policy, and this he did in a most comprehensive manner, pointing out clearly not only what had been accomplished but what was contemplated for the future.

In reviewing the past and outlining future progress Mr. Aishton presented by graphic chart and in tabulated form figures that were gratifying as to the past and should inspire all to renewed energy in the future.

Some of the most essential points touched upon were as follows:

Constructive Transportation Programme for 1923

Cars of Revenue Freight Loaded 37 weeks, July 1 to March 17, 1923: 32,939,789, 1922; 28,879,325, 1921; 31,312,945, 1920; 31,668,856, 1919; 30,819,593, 1918.

This record to be exceeded in October, 1923, by approximately 21 per cent by graphic chart estimate.

New Equipment Purchased in 1922

Freight cars	223,616
Locomotives	4,219

Aggregate carry capacity of freight cars increased in ten years 1912-1921, inclusive, 229 per cent. Tractive Power of locomotives during same period, 40.8 per cent.

The railroads in full realization of the necessity for the greatest improvement and expansion possible of the country's transportation facilities to meet the growing demands of commerce, actually expended in the year 1922:

For cars	$200,000,000
For locomotives	45,000,000
For trackage and other facilities	195,000,000
Total	$440,000,000

The railroads have authorized expenditures for equipment and other facilities of approximately $1,100,000,000 for the year 1923, divided as follows:

For cars	$515,000,000
For locomotives	160,000,000
For trackage and other facilities	425,000,000
Total	$1,100,000,000

The railroads of the country are raising this enormous amount of additional capital largely through borrowed money on the abiding faith in the firmness of the American people and reliance on the continuance of the policy announced in the Transportation Act, 1920, as a measure of reasonable protection to investment in railroad property.

Deferred Maintenance Program, 1923

That by October 1, 1923, when the peak movement ordinarily begins, cars awaiting repairs be reduced to the normal basis of five per cent of the total equipment of the country.

That by October 1, 1923, locomotives awaiting heavy repairs be reduced to the normal basis for the entire country of fifteen per cent.

Mr. Aishton also reminded the members that they could and should exercise their influence at all time toward a more favorable public sentiment for railway interests, thus counteracting the mischievous activities of all anti railway propaganda.

W. B. Storey's Address

It is fortunate indeed that the Mechanical Division of the American Railway Association, has the benefit of the guiding hand of W. B. Storey and his address as chairman of the section, was most able, clear cut, and business like in every respect, and from which we make the following brief extract:

For many years you comprised two organizations—the Master Car Builders' and the Master Mechanics'. Most of the motive power officials were members of both associations. When the reorganization took place, by which the Mechanical Division was formed, many of you felt that the passing of the old organization meant the end of the work in which you had all become so interested, and you accepted the new order of things with some question as to whether it would really fill the place so long held by the original bodies—and with some it has been hard to feel as much interested in the present plan as in the old. One of the tasks before you, therefore, is to restore the morale which actuated you so strongly in the old days.

Valuable Work Accomplished by Some Committees

There is, of course, no question as to the work that is being accomplished by some committees, but there are many directions in which nothing is being done. Let us, therefore, take a quick review of your various committees. Those that are on the list of what I might call active committees are the Arbitration, Prices for Labor and Materials, Car Construction, Couplers and Draft Gear, Brakes and Brake Equipment, Train Brake and Signal Equipment, Wheels, Loading Rules, Safety Appliances, Locomotive and Car Lighting, and finally the special committee on Tank Cars. All these committees are very much alive and doing very valuable work—I might say, that this is work which is absolutely essential to the every day handling of interchange.

Then there are the inactive committees, if I may so style them, viz., Autogenous, and Electric Welding, Feed Water Heaters for Locomotives, Mechanical Stokers, and Electric Rolling Stock. While the work of these committees may be classed as not of first importance so far as interchange of cars is concerned, it is highly important from an economic point of view and much could be accomplished if this work was actively pushed. The cost of the committee work should not be heavy and much can be accomplished for the common good.

Mechanical Officers Carry Heavy Responsibilities

I think you all recognize the tremendously important part you play in the general plan of railroad transportation, but I sometimes doubt if our executives, as a class, realize it. On the Santa Fe Railroad last year practically 30 per cent of our entire expenditure for the year went to maintenance or equipment—or nearly one-third of the entire expenditures of the road. The proportions on one road are representative of the country as a whole, and you can thus see what a tremendous responsibility rests on you. It is because of this large interest that lies in the mechanical end of our work that the Santa Fe for one is ready to back any program that makes for economy. I therefore ask you to take yourselves seriously and to strive to make the Mechanical Division the live force that it should be.

Address of C. H. Markham

On the second day of the convention Mr. C. H. Markham, President of the Illinois Central Rairoad, delivered a most interesting and instructive address in his usual masterly manner.

Mr. Markham does not mince matters when dealing with serious problems of finance, public sentiment, or railway management, and in his short forceful address left no doubt in the minds of his hearers as to what they should do for the railways, and what they should assist in doing to those who oppose railway interest.

All were agreed that Mr. Markham's formulæ for curing present ills to be a good one.

Following Mr. Storey's address a paper on the development of the locomotive written by Samuel Vauclain, president, Baldwin Locomotive Works, was read. Other individual papers presented at this convention included a paper on training of apprentices by John Purcell, assistant to vice president, A. T. & S. F. Ry., an illustrated paper on the Development of Railway Cars, by E. F. Carry, president of the Pullman Company, and Increasing Mileage of Locomotives by C. F. Giles, superintendent of Machinery of the L. & N. Railroad. These papers are all published elsewhere in this issue.

The terms of office of the chairman, vice chairman and seven members of the general committee expired June, 1923. In accordance with action taken by the general committee and recommended in its report this year as result of a resolution adopted at the 1922 annual meeting, the term of chairman and vice chairman of the Mechanical Division was changed from two years to one year. John Purcell, assistant to vice-president, Atchison Topeka & Santa Fe Ry., was elected chairman. T. H. Goodnow, superintendent, car department, Chicago & North Western Ry., was elected vice chairman. The following were elected to serve until June, 1924 as members of the general committee: C. E. Fuller, superintendent, motive power and machinery, Union Pacific Ry.; H. L. Ingersoll, assistant to president, New York Central R. R.; Willard Kells, superintendent motive power, Atlantic Coast Line R. R.; J. S. Lentz, master car builder, Lehigh Valley R. R.; H. C. Oviatt, general mechanical superintendent, New York, New Haven & Hartford R. R.; J. J. Tatum, superintendent car department, Baltimore & Ohio R. R.; W. J. Tollerton, general superintendent motive power, Chicago, Rock Island & Pacific R. R. J. Coleman was also elected a member of the general committee to fill the unexpired term of T. H. Goodnow, and C. H. Temple, chief of motive power and rolling stock, Canadian Pacific Ry., was elected to fill the unexpired term of W. H. Wintorrowd, who recently left railroad service to become assistant to the president of the Lima Locomotive Works.

A Standard Box Car

Thursday, June 21st will, in years to come, be looked back to as the day on which the master car builders of American railways agreed, in convention, on a standard box car, and while the specifications, dimensions, etc., do not at once supersede or displace other existing standards of the association, this latest design will no doubt, with possible slight modifications, become standard and thus gradually displace many thousands of cars that are now operated at an economic loss, and also save great sums of money in the item of repair parts carried in stock by the owners and other carriers with whom they interchange. The combined savings will run into many millions.

Leaders in the Field of Railway Engineering

A glance at the names of the men on the committee who worked out the details of design of this standard car is sufficient proof of high character of the work accomplished and that all interests were represented it is therefore the product of the best brains in the railway equipment field. It is also worthy of note that while the committee, from a geographical standpoint, covers the entire country, thus providing full and fair representation to all interests, the committee also represent a total of 890,000 freight cars out of a total of 2,380,000 or more than 32 per cent of all the freight cars represented in the association.

The full committee is as follows:

W. F. Kiesel, Jr. (Chairman), Mechanical Engineer, Pennsylvania System; A. R. Ayers, Assistant General Manager, New York, Chicago & St. Louis Railroad; C. E. Fuller, Superintendent Motive Power and Machinery, Union Pacific Railway; J. C. Fritts, Master Car Builder, Delaware, Lackawanna & Western Railroad; C. L. Meister, Mechanical Engineer, Atlantic Coast Line Railroad; J. McMullen, Superintendent Car Department, Erie Railroad; T. H. Goodnow, Superintendent Car Department, Chicago & Northwestern Railway; John Purcell, Assistant to Vice President, Atchison, Topeka & Santa Fe Railway; W. O. Moody, Mechanical Engineer, Illinois Central Railroad; J. A. Pilcher, Mechanical Engineer, Norfolk & Western Railway; H. L. Ingersoll, Assistant to President, New York Central Railroad; W. H. Wilson, Assistant to Vice President, Northern Pacific Railway; F. W. Mahl, Director of Purchases, Southern Pacific Company; G. S. Goodwin, Mechanical Engineer, Chicago, Rock Island & Pacific Railway.

In compliance with instructions to prepare box car designs, the committee made a thorough investigation of the state of the art, including the present day requirements, and selected a basis contemplated to result in a car of adequate strength and minimum weight, with minimum cost of maintenance. Fundamentals covering present day requirements and adequate strength have been submitted to the division heretofore, and have been adopted as standard.

The report, consisting of some 68 pages of reading matter and drawings, was presented by W. F. Kiesel, Jr., following which F. H. Hardin, Chief Engineer of Rolling Stock of the New York Central, and L. K. Sillcox, Gen. Supt. of Motive Power of the Chicago, Milwaukee and St. Paul, in rather extended remarks offered criticisms of several features of the proposed design. Prior to further discussion, Mr. Kiesel in replying to the two foregoing speakers cleared up much of the apparent misapprehension in the minds of many as to certain existing standards and interchange features.

In Mr. Hardin's remarks opening the discussion on the proposed standard box car he not only very clearly pointed out several features which his remarks indicated might not yet be acceptable as standards, but closed with a motion, that the Committee's report on car construction be accepted as a report of progress only.

This motion was seconded and following explanations made by Mr. Kiesel, who was chairman of the committee and presented the report, the discussion was renewed and actively participated in by Messrs. Kiesel, Hardin and Kleine. When T. H. Goodnow, Supt. of the Car Dept. of the Chicago & Northwestern came into the breach and clarified the atmosphere wonderfully by the following remarks on the subject.

"It is my idea to make definite progress and as the end is a standard we can simply change the report and accept that portion of the committee's report which refers to its design and embody in that the wording of the present A. R. A. standard. That will take care of the big part. The roof is entirely optional. You can use any roof desired under the committee's report. If the question of top and bottom hung doors and release rigging is going to tie up anything in the progress of this car I would leave them off for this year. I think that we can maintain the interchangeability of the trucks. The only thing that impresses me as being essential is the height and general dimensions of the truck. We don't have to have a bolted box. If I want to use the bolted type of truck frame under our car so long as I make it to the general dimensions I can do it."

Following Mr. Goodnow's remarks there still appeared to be a lack of full understanding and the discussions between Messrs. Goodnow, Tatum and Kiesel continued with the result that on request of chairman Coleman, Mr. Hardin consented to withdraw his motion with permission of the second and substituted the following instead.

Mr. Hardin: I will withdraw my motion and I want to make a motion in this form: First, that on the drawing included with the report of the Committee on Car Construction and entitled, "End Sheets," the following notation be made: "A. R. A. recommended practice adopted 1914, revised 1920, as a part of this specification."

Second: On the drawing accompanying this report which is entitled, "Coupler Release Details," the following notation be made: "Any other type of release rigging conforming to the safety appliance laws may be substituted as an alternate."

Third: On the drawing entitled "Steel Frame Door Arrangement," the following notation be made: "Door of bottom supported type may be used as alternate if conforming to general dimensions."

Fourth: On the drawing showing outside metal roof, eliminate the note reading "Outside metal roof of manufacturers' designs must be made to suit dimensions shown and be interchangeable," and substitute the following notation: "Any outside metal roof may be used as alternate if conforming to general dimensions shown."

Fifth: On the drawing showing roof sheets of all-steel roof the following notation be made: "Any design of riveted roof may be used as alternate if conforming to general dimensions."

On the drawings showing proposed design for standard trucks, Classes 2-C, 2-D and 2-E Types and Y, the following notation be made: "Any truck of proper capacity conforming to the A. R. A. standard dimensions may be used as alternate."

Mr. Kiesel: "I can say for the Car Construction Committee that we can accept all of those notations because they conform closely with the intent of the committee in having this a car on which alternates can be used, and this merely makes it a little more specific than what we now show."

(The motion was duly seconded and carried.)

The report of the committee, with the amendments submitted by Mr. Hardin, was put to a vote and was accepted.

Thus what for a time seemed to be an element of doubt as to whether the railways were going to be able to avail themselves of the wonderful work of this committee was cleared up in such manner that during the next year or two, no doubt the leading companies who are adding to their equipment will build a large number of cars to these drawings and specifications and thereby profit by the result of this committees labors and pave the way for the ultimate standardization of box cars for all except some special kinds of service.

In fact it now looks to those who forecast the future, that the railways who interchange equipment will gradually work toward what might be called a legal tender car, one which is not only interchangeable as a complete unit, but the integral parts thereof being standard will materially reduce the amount of idle money invested in repair parts. It will also automatically minimize to a great degree the present injustice which results from one road owning small light-capacity cars of antiquated design interchanging them with those of another company who have up-to-date, ultra modern equipment on a basis of equality, which is manifestly unfair to the shippers and a great injustice to the owners of the modern car which in many cases represents an investment of twice or three times that of the car offered in interchange and on which the same per diem must be paid. The committee is to be congratulated on its work, and the railway companies now have an opportunity to show their appreciation by giving cordial support to its findings and this can be done without any material sacrifice.

Increasing Mileage of Locomotives

Individual Paper Read at Mechanical Division of the A. R. A. Meeting

By C. F. GILES, Superintendent of Machinery, Louisville & Nashville Railroad

The factor average locomotive mileage is primarily one in which the Mechanical Officials of the railroads are chiefly concerned for the reason that it affords an accurate record of a character that fairly reflects, in a large degree, the measure of service that is being obtained from the motive power of a certain road as compared with some previous period or with that of other railroads. The locomotive may undoubtedly be considered as the fundamental unit of earning power of a going railroad and, therefore, representing as it does, such a large capital investment, it is obvious that a more intensive use of this equipment within practicable limits will admit of handling a larger volume of business with the same number of locomotives, which will be productive of increased returns in revenue and consequently, greater economy of operation, the ultimate goal sought. However, there are many elements that have a direct or indirect influence upon the matter of increasing the average mileage of locomotives, which I will briefly dwell upon as follows:

Pooling and Distribution of Power

Of most importance, especially in freight service, is the pooling of locomotives, that is, running them first in and first out, or in the order in which they can be gotten ready for service. The distribution of power should be under the absolute control of the Chief Mechanical Officer, or his representative, who will be charged with the responsibility of supplying each division, or territory, with the power needed, or in transferring same from one division or territory to another where it can be used to the best advantage.

Daily Situation and Report Showing Time in Engine House

To handle the matter successfully, he must keep himself fully informed as to the conditions existing on each division at all times. First, he should have a daily report to be furnished by the division officers, showing separately for each division the situation each morning, that is, the amount of tonnage ready to move and number of locomotives available. He must also maintain a daily check as to the power situation at all engine terminals or turning points and have some means of knowing the time required to get engines ready by the mechanical forces, and also know if locomotives are being used promptly by the Transportation Department after they have been made ready for service. The following form is suggested and has proven of inestimable value for this purpose:

DAILY TIME REPORT OF FREIGHT LOCOMOTIVES HANDLED IN AND OUT

(Name of Station) ENGINE HOUSE....(Date)....1923

Loco.	Arrived			Departed			In Eng. House		Locomotive was Ready			Loco. held after being reported as ready for service		Remarks
	Date	Time	AM or PM	Date	Time	AM or PM	Hrs.	Min.	Date	Time	AM or PM	Hrs.	Min.	
	Total													

NOTE.—When delays occur on account of necessary work being done, full explanation must be made in Remarks column.

These forms should be prepared for each twenty-four-hour period by the Mechanical Officers in charge at each engine terminal and forwarded promptly each day to the office of the Chief Mechanical Officer, a copy also being furnished to the Superintendent of the Division. The Chief Mechanical Officer, or his representative in charge of locomotive operation, will then be in full possession of all information as to the time required to handle each locomotive and may call for a further explanation where it is deemed necessary.

Consolidated Report Showing Time in Engine House

A consolidation of these reports is made daily in the office of the Chief Mechanical Officer showing the following results for each division, and a copy of same furnished to the Chief Officer in Charge of Operations and in Charge of Transportation.

STATEMENT SHOWING TIME OF FREIGHT LOCOMOTIVES IN ROUNDHOUSE, AND LEAVING DURING TWENTY-FOUR HOURS

ENDING MIDNIGHT.......................1923

Divn.	Place	Total No. Locos. Turned	Minimum Time		Maximum Time		Total Time of all Locomotives		Time Held Ready for Total		After Service Average	
			Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.

Advance Information as to When Engines Will Be Ready for Service

In addition to these reports it is necessary, in order to prevent unnecessary delay to power after an engine has been made ready for service, to have an arrangement in effect whereby the Round House Foreman, or proper designated party, will keep the Dispatcher, or other designated officer of the Transportation Department in charge of the calling and dispatching of trains, informed as to the probable time of day or night that locomotives will be ready for service. This information should be furnished the Transportation Department as soon as possible after the engine reaches the roundhouse. If considerable work is required and it is impossible to make the estimate at the time of arrival, it should be done after the work of repairs has progressed sufficiently to enable him to determine about when it will be ready. A proper spirit of co-operation between the Transportation and Mechanical Departments is essential, as it has been found by actual experience that a very great reduction can be made in the time the engines are held in the Engine House by the above arrangement. An occasional delay in getting a train out on call by reason of the engine not being ready at the time it was first estimated is more than offset by the time saved in getting engines and trains out faster and more readily than would be the case if they waited until all repairs were completed and the engine made ready in every respect before anything is said to the Transportation Department.

Responsibility for Utilization of Power

Where the distribution of power is under the supervision of the Transportation Department and the maintenance under the Mechanical Department, the latter have no special interest in the utilization of same after it has been prepared for service. Under the plan of holding the Mechanical Department equally responsible for its distribution, as well as its maintenance, should it develop that the Transportation Department is not promptly using the power after having been prepared for service, the surplus power may be shifted to other points where it can be utilized to better advantage. This method of distributing power has a very material tendency to increase the average locomotive mileage and produces highly beneficial and efficient results in many other respects.

Advantages of Pooling Locomotives Versus Assigning Locomotives to Regular Crews

While the question as to the advisabliity of pooling locomotives and with respect to the opposite plan of assigning locomotives to certain engine crews appears to be divided, as both plans have their proponents and are in effect on a number of railroads, it stands to reason that a well organized pooling system in which the engines are delivered to service in the order as they can be first made ready, regardless of engine crews, thereby reducing the time engines are held at terminals, will unquestionably effect a more intensive use of the power and, consequently, reflect in increased locomotive mileage. It is recognized that locomotives, when assigned to regular crews may, to some extent, receive slightly better care while in their charge that when pooled, notwithstanding this fact the benefits from that source cannot be held to equal or offset the advantages had from the more intensive use and increased mileage under a properly organized pooling system. I have had experience with both plans on the same railroad for a number of years and unhesitatingly recommend the pooling plan as being the more economical and efficient from a general standpoint.

Prompt Handling at Engine Houses and Terminals

Any reduction of the period from the time a locomotive is detached from the train in the yard until it has been given the necessary attention in the engine house, made ready and attached to another train that is called to depart, should generally accrue to productive time and thus increase locomotive mileage. Therefore, it is obvious that the following operations should be handled with prompt dispatch, viz: the movement between train yard and engine house, over the cinder pit and into the engine house for repairs, if necessary, otherwise over the repair or inspection pits outside of the round house, the coaling, watering, sanding and providing the necessary engineer's tool equipment, oil cans and supplies, and the outward movement to the train yard sufficiently in advance of the time that the train is called, to admit of departure without delays. Inasmuch as the time devoted to extending repairs in the engine house usually consumes a large proportion of the total time that engines are held at terminals, the provision of adequate mechanical facilities at engine terminals, for promptly effecting necessary repairs, is a matter of vital importance. It is needless to state in detail the character of facilities that should be provided for the purpose, as this has been a live subject for the past few years, and all railroad officials undoubtedly realize what is needed in this respect at their various engine terminals.

Accounting for Mileage

That the Chief Mechanical Officer and others interested in the subject may know to their personal satisfaction whether or not the results on their respective properties are good, bad or indifferent, it is suggested that they cause an investigation to be made to determine the following factors:

1. Are your locomotives being credited with all the mileage actually made, including Arbitrary Switching Miles, which, under the instructions contained in the I. C. C. Classifications of Accounting Rules, are to be allowed at the rate of six miles per hour for the total time consumed in switching at line-of-road points?

2. Compile statement showing total miles made by individual locomotives each month in passenger and freight service, and after ascertaining the total average number of locomotives in service, less those in shops for classified repairs, divide the total mileage by the number of locomotives in service and thus determine the average miles made by each locomotive. Comparison can then be made with previous month, or previous year, and the matter followed up in this manner. Unless the officer in charge has this data, he is working in the dark.

Work of Committee on Brakes and Brake Equipment

Since the last report rendered by the Committee their time has been almost wholly occupied in assisting the Safety Appliance Committee and taking care of conditions due to the labor troubles. A number of subjects, which he had on the docket, have been of such a nature as to require considerable time of the members to adequately care for them. The conditions enumerated have made it impossible, therefore, for your Committee to cover the subjects sufficiently to enable them to render a report of any value and the subjects have, therefore, been continued on the docket for future consideration. The Committee has been able to cover one or two subjects which are being submitted.

In the Committee's report for last year attention was called to having appointed a Sub-Committee on Train Brake and Signal Equipment to work in conjunction with Committee from Operating Division in revising the latest Code of Air Brake and Train Signal Rules. This Committee has performed the duty for which it was appointed. Meanwhile, the Mechanical Division's Standard Rules and Instructions Governing the Testing, Inspection, Maintenance and Operation of Brakes and Signal Equipment have been carefully reviewed and the following recommendations are submitted:

Maintenance of Brake and Train Air Signal Equipment

Rules and regulations for testing, inspection, maintenance and operation of power brakes (freight and passenger):

(1) Replacing the air brake and train air signal instructions, shown on pages 55 to 74 of Section "E," Manual of Standard and Recommended Practice, with a suitable code of rules governing the operation of this equipment.

The Committee has, therefore, prepared a proposed set of rules governing the operation of brake and train air signal equipment. These rules are shown in Exhibit "1" of the appendix of this report and are recommended for adoption as standard.

(2) A set of proposed rules governing the maintenance of brakes and air signal equipment on passenger cars, as shown in Exhibit "2" of the appendix of this report, similar to the standard rules governing the maintenance of freight brakes, and the same is recommended for adoption as standard.

The Committee has carefully reviewed the rules and instructions in the Manual of Standard and Recommended Practice on the maintenance of freight brakes and while it does not find that these rules and instructions are subject to important fundamental revision there are a number of cases in which the rules can be clarified.

(3) It is, therefore, recommended that they be revised to conform to Exhibit "3" in the appendix of this report. In view of there being no important changes involved, no attempt has been made to enumerate the revision in detail.

(4) If the foregoing recommendations are adopted, the instructions for operating the Standard No. 1 and No. 2 triple valve test racks on pages 41 to 54 of the Manual should be added to Exhibit "3" and bound with Exhibits "1," "2" and "3" in one pamphlet for distribution.

The general arrangement and details of the air brake parts, shown on pages 3-9 and 11-13, and the details for high speed foundation brake gear, shown on pages 20-31 of the Manual, are not suitable in-so-far as dimensions are concerned for cars of present day construction. In fact, owing to the many different types of cars in use and being constructed, it would be very difficult to prepare complete detail drawings for the various parts of the brake rigging that would be suitable for the many types of cars involved.

(5) It is, therefore, recommended that the details shown on pages 3-9, 11-13, 20-31 and the six paragraphs appearing on page 19 of the Manual under "Designation of Rods and Levers" be stricken out of the list of standards and recommended practices and supplemented by specifications covering fundamental requirements for foundation brake gear and application of brake equipment to the car.

If this recommendation is adopted the Committee will prepare specifications to cover.

We understand the design of standard freight cars, which is in the hands of the Car Construction Committee, will include brake rigging for such cars.

Report on Locomotive Design and Construction

Design and Performance of Locomotive Specialties a Feature

H. T. Bentley, chairman of the committee on locomotive design and construction presented a splendid report which he and the sub-chairman all took much interest in. The members however with few exceptions failed to respond, taking little or no part in the discussions although the subjects were live ones and of much interest to the railways in general. The members of the committee deserve much credit for their work on the different subjects.

Mechanical Stokers

The number of stokers of each type that are in service or on order as of April 1, 1923, are shown in the accompanying table:

Number of Stokers as of April 1, 1923

Manufacturer	In service	On order	Total	
Elvin Mechanical Stoker Company				
Type A	5	10	15	
Type B	247	102	349	
				364
Hanna Stoker Company				
Type V-H	109	0	109	
Type H-2	8	57	65	
Type S 1	34	0	34	
				208
Locomotive Stoker Company				
Type Street	1,458	0	1,458	
Type, Duplex	4,142	772	4,914	
				6,372
Standard Stoker Company				
Type A 1	510	0	510	
Type A 1M	102	0	102	
Type DuPont	65	0	65	
Type DuPont Simplex	34	59	93	
				770
Grand total				7,714

Longer experience with mechanical stokers has led the committee to the conclusion that while a stoker designed to handle run-of-mine possesses merit, this feature might well be sacrificed for further improvements in design and ability to perform the stoking operation and the exploitation of machinery for the preparation of fuel at coaling stations or whenever it might best be handled. This preparation should include not only crushing the coal so that it may be satisfactorily handled on the stoker without further preparation but also the grading to the extent of removing, as far as warranted, the finely divided material which would result in materially increasing stack losses.

Alexander Kearney of the Norfolk & Western, chairman of the sub-committee presented this report and recommended the subject be now turned over to the fuel committee as the matter had now resolved itself largely into a question of selection of fuel, stoker type being a matter of preference, and mechanical improvement being common to all types. Mr. Kearney indicated that stock losses at times reached as high as 47 per cent and that cost of maintenance about one-tenth of the cost to maintain the locomotive.

M. H. Haig, of the Atchison, Topeka and Santa Fe, spoke of limited space in location and need of greater accessibility for repairs. Two to three years wear of stoker parts after which time many parts fail and require renewal.

Messrs. Giles, Gray, and Oviatt discussed the subject, the latter making two attempts to get some one of the numerous members who have such a wonderful fund of information on the subject, so freely expressed outside the convention hall, to loosen up as it were and allow some of this useful information to ooze out to the benefit of others but to no avail, and dispairing of any response the chairman of main committee, Mr. Bentley, to avoid waste of valuable time called for previous question on Mr. Kearney's motion which having been duly seconded was put and carried thereby passing the stoker question to the fuel committee.

Force Feed Lubrication

The committee reports that there has been no rapid development in the extension of the force feed system of lubrication to locomotives although the adaptability of the force feed lubricators to locomotive practice as indicated by a few scattered installations has been under investigation for a number of years. In the introduction of the force feed lubricator to locomotive service, it was soon discovered that there were problems in design that must be reckoned with that had not appeared in connection with the use of the same type of lubricators in stationary practice. In order, therefore, to meet the more exacting conditions imposed in locomotive service, it was necessary to develop into the construction of the lubricators certain features of ruggedness and dependability that were not necessarily essential to successful operation in stationary practice.

There are a number of representative railway mechanical officials who differ in their opinions as to the relative merit of force feed and hydrostatic lubrication.

There are some who, through a process of consistent and logical reasoning, possibly prompted by the observations of the performance of force feed lubricators, are staunch supporters of the force feed method of lubrication and consider it superior to the hydrostatic principle. On the other hand, there are others, possibly representing a majority, who are equally staunch advocates of the hydrostatic method of lubrication. It may be, in many instances, the knowledge of unsatisfactory results with force feed lubricators in the earlier designs has, in a measure, shaped the attitude they have taken although they support the stand they have taken as advocates of the hydrostatic principle of lubrication by a logical process of reasoning.

The Committee, in canvassing the force feed lubrication situation, was advised that there were twelve railroads upon which the method of force feed lubrication was being investigated. A questionnaire was prepared with the purpose of covering some of the more pertinent factors relative to the two systems of lubrication and sent to the roads reported as having force feed installations.

It may be of interest to indicate the roads replying to the questionnaire showing the type and number of force feed lubricators they have in service and the location of the oil delivery:

Road	Lubricators System	No.	No. of Feeds	Location of Oil Delivery
C. & E. I.	Schlack	1	2	In outside steam pipe.
C. & N. W.	Schlack	—	2	In outside steam pipe.
	Madison-Kipp	—	2	In outside steam pipe.
	Nathan Mfg. Co.'s Friedmann	—	6	In outside steam pipe.
C. M. & St. P.	Schlack	1	2	In outside steam pipe.
D. L. & W.	Madison-Kipp	—	2	In main steam pipe.
	McCord	—	2	In main steam pipe.
Grand Trunk	Had Intensifore and Wakefield. Both now removed.	—	5	To outside steam pipe and to top of cylinder barrel.
N. & W.	Schlack	1	2	In top of cylinder bar.
	McCord	5	2	To mallet LP cyls.
	Goodfellow	1	4	To steam pipe.
	Madison-Kipp	1	2	To steam pipe.
Pennsylvania	Nathan Mfg. Co.'s Friedmann Type FSS	1	6	To steam pipe.
	Nathan Mfg. Co.'s Friedmann Type DV	1	6	To steam pipe.
	McCord	50	2	To steam pipe.
	Schlack	50	2	To steam pipe.
Southern Pacific	Nathan Mfg. Co.	—	4	One to each steam pipe and top of cylinder barrel.
Union Pacific	Madison-Kipp	—	4	One to each outside steam pipe and top of each cyl. barrel.
	Schlack	—	4	Bottom of cylinder.
Erie	Madison-Kipp	—	4 & 6	Bottom of cylinder.
	Nathan Mfg. Co.	—	4	Bottom of cylinder.

The three systems of force feed lubrication that have received any measure of recognition by the railroads are the Nathan Mfg. Co's Friedmann, Madison-Kipp, Schlack (formerly identified as the McCord).

The Committee, in its efforts to gather together information that would be of value to the Association in the consideration of this subject has not met with the success that should attend the pursuit of a subject of such primary importance and which should undoubtedly lead to improvement in valve and cylinder packing ring service. The roads that have taken the initial step in the application of one or more force feed lubricators have shown a disposition to co-operate with your Committee by supplying such information as they have relative to the lubricators but they were not in position to furnish data that would be indicative of the relative results obtained from force feed and hydrostatic lubrication, doubtlessly due to the limited experience they have had with force feed lubricators and their records of the relative performance of hydrostatic and force feed systems were not complete.

In the discussion on this subject Messrs. Hardin, Brooks, Kearney and Lanning participated, but nothing constructive or of real value was brought out, although Mr. Brooks mentioned an increase of 30 per cent in mileage made with force feed lubrication, and 35 to 50 per cent in life of packing rings.

The subject will be continued with suggestions from the committee as to conducting tests of different types of lubricants.

Taking Up Driving and Truck Wheel Lateral

From the information that the committee was able to obtain no patented devices have been applied in quantity and little is known of the service, application and maintenance costs.

In the absence of conclusive information as to the reliability of the various patented devices for taking up driving and truck wheel lateral, and in view of the satisfaction evidently obtained either by pouring or pinning bronze liners to the face of the driving box or wheel hub, as evidenced by their almost universal use, it would seem that until some better device is developed that the liner poured or pinned to the driving box face or driving wheel hub is the best means of taking up lateral.

Driving wheel lateral: Discussed by Messrs. Gray, Chambers, Cadington, Goodwin and Wiggins.

Repeated calls for information as to some of the special methods such as pressure from grease back of loose liner, but not a word or even a grunt from any one. The remarks were entirely on conventional types of liners, brass, cast iron, steel cast, plate, etc.

If the members' aversion to speaking on the subject may be taken as a measure of progress then there is nothing new in this line.

In all walks of life are men, who under certain circumstances are brave as a lion while the same individual may at times be as meek as a lamb.

A most striking example of this dual personality was revealed in repeated attempts on the part of Messrs. Bentley, Giles, Kearney, Oviatt, Chairman Coleman and a few others to get the members to respond. Numerous members with a storehouse full of important information, who when outside the hall are usually afflicted with chronic "Furore Liquendi" seemed to have become ossified when in the convention hall, and no amount of persuasion would induce them to get up on their hind legs and talk.

Tractive Power Mallet Locomotives

The formula now in general use for the simple locomotive gives only a close approximation of the actual tractive power for such a locomotive, because simple locomotives vary in maximum cut-off, back pressure, internal friction, etc. The same reasons that justify the adoption of a uniform formula for tractive power for simple locomotives, also justify the adoption of a uniform formula for the Mallet locomotive, but it must be understood that the formula adopted will give only a close approximation of the actual performance of the Mallet locomotive.

There are two general types of Mallet locomotives:

1st, the four cylinder simple, and

2nd, the four cylinder compound.

C = Diameter of high pressure or simple cylinder in inches.

c = Diameter of low pressure cylinder in inches.

S = Stroke in inches.
P = Boiler pressure in pounds.
D = Diameter of driving wheels in inches.
H = M. E. P. of high pressure or simple cylinder in inches.
E = M. E. P. of low pressure cylinder in pounds.
R = Ratio of cylinder volumes.
K = A constant—.85 for 90% cut-off locomotives and .75 for 50% cut-off locomotives.
Q = PK = Total M. E. P. in cylinders.
T = Tractive power in pounds.

Of the values of "K" given above, the first has been generally adopted for simple locomotives having approximately 90 per cent cut-off. The second value, that for locomotives having approximately 50 per cent cut-off, is taken from results obtained with the Pennsylvania class I1s (2-10-0) locomotive. Each piston valve bushing of these locomotives is provided with an auxiliary steam port ⅛ in. by 1½ in. in size and having ¼ in. steam lap. While the steam which passes through the auxiliary ports has an effect on the mean effective pressure, it is believed that the constant .75 may be used for any locomotive having approximately 50 per cent cut-off.

The four cylinder simple is essentially nothing more than two simple locomotives with but one boiler. Therefore, the tractive power of this type of locomotive is double that of the simple locomotive, or

$$T = \frac{2\,K\,P\,C^2\,S}{D}$$

which becomes— $= \dfrac{1.7\,P\,C^2\,S}{D}$ for 90% cut-off locomotives, and

$= \dfrac{1.5\,P\,C^2\,S}{D}$ for 50% cut-off locomotives.

The four cylinder compound is usually equipped with a device by means of which the locomotive can be operated as a simple locomotive at certain times. Under this condition the tractive power of the locomotive would be

$$T = \frac{(H\,C^2 + E\,c^2)\,S}{D}$$

In a properly designed compound locomotive, it is intent that the piston pressures will be equal. If they were not equal, one pair of cylinders would do more work than the other which would be uneconomical. Therefore, we may assume that the mean effective pressures vary inversely as the squares of the cylinder diameters, or

$$\frac{H}{E} = \frac{c^2}{C^2} = R \qquad (1)$$

Now the sum of the mean effective pressures of the high and low pressure cylinders will be equal to the total mean effective pressure, or

$$H + E = Q \qquad (2)$$

Substituting value of H from formula (2) in formula (1), we have

$$\frac{Q - E}{E} = R \qquad (3)$$

From which

$$E = \frac{Q}{R + 1} \qquad (4)$$

The tractive power of the low pressure cylinders is

$$T = \frac{E\,c^2\,S}{D} \qquad (5)$$

Substituting value of E from formula (4) in formula (5), we have

$$T = \frac{Q\,c^2\,S}{(R + 1)\,D} \qquad (6)$$

Since we have assumed equal power for the high and low pressure cylinder, the tractive power of both pairs of cylinders is double that of the low pressure cylinder, or

$$T = \frac{2\,Q\,c^2\,S}{(R + 1)\,D} \qquad (7)$$

which becomes— $T = \dfrac{1.7\,P\,c^2\,S}{(R + 1)\,D}$ for locomotives with approximately 90% maximum cut-off, and (8)

$T = \dfrac{1.5\,P\,c^2\,S}{(R + 1)\,D}$ for locomotives with approximately 50% maximum cut-off. (9)

For comparison, the proposed formulæ are given in connection with other formulæ in general use, all formulæ given being for four cylinder locomotives, except as noted:

	Tractive Power	Simple or Compound	Approximate Maximum Cut-off Percent	Cylinder Ratios	Authority
1	$T = \frac{1.7\,P\,C^2\,S}{D}$	Simple	90	....	Proposed
2	$T = \frac{1.5\,P\,C^2\,S}{D}$	Simple	50	....	by
3	$T = \frac{1.7\,P\,C^2\,S}{(R+1)\,D}$	Compound	90	All	Sub-
4	$T = \frac{1.5\,P\,C^2\,S}{(R+1)\,D}$	Compound	50	All	Committee
5	$T = \frac{1.2\,P\,C^2\,S}{D}$	Compound	90	2.35-2.40	Baldwin Loco. Works
6	$T = \frac{1.7\,P\,C^2\,S}{(R+1)\,D}$	Compound	90	All	Baldwin Loco. Works
7	$T = \frac{K\,P\,C^2\,S}{D}$	Compound	90	‡‡	American Loco. Co.
8	$T = \frac{1.6\,P\,C^2\,S}{(R+1)\,D}$	Compound	90	All	C. R. Henderson Loco. Operation
9	$T = \frac{2\,P\,C^2\,S}{3\,D}$	Two Cylinder Compound	90	....	Interstate Commerce Commission Circular No. 22
	$T = \frac{P(\frac{2}{3}C^2 + \frac{1}{4}C^2)\,S}{D}$	Compound	90	....	

‡‡ See Table 1 for value of K.

TABLE No. 1—CONSTANTS ("K")

Per Cent Cut-off H. P. Cylinder	Ratio of L. P. to H. P. Cylinder Volume						
	2.2	2.3	2.4	2.5	2.6	2.7	2.8
90......	......	......	.571	.557	.542	.528	.513
89......	......	......	.565	.550	.536	.521	.507
88......	......	.573	.559	.543	.529	.515	.500
87......	......	.567	.552	.537	.523	.509	.494
86......	.575	.560	.546	.531	.517	.502	.489
85......	.570	.555	.540	.526	.511	.497	.483
84......	.564	.550	.534	.520	.506	.491	......
83......	.559	.544	.529	.515	.500	.486	......
82......	.553	.541	.524	.510	.496	......	......
81......	.548	.534	.520	.505	.490	......	......
80......	.543	.531	.515	.500	.486	......	......

European Mikado Type Express Passenger Locomotive

A Four Cylinder Compound 2-8-2 Type Locomotive—Extended Use of Compound Expansion Abroad

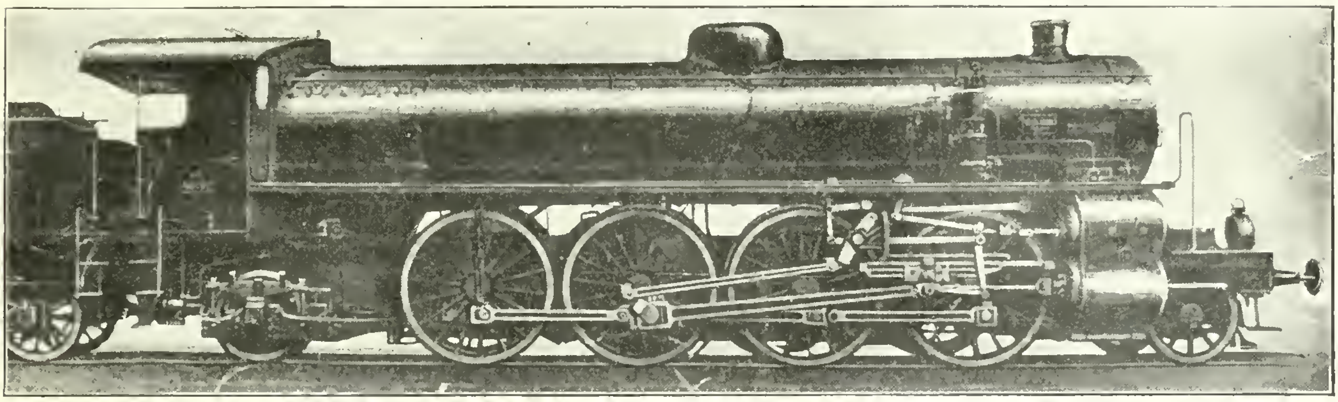
By CHARLES R. KING

In continental Europe the Mikado express passenger locomotive is beginning to supersede the Pacific type, no longer capable of providing the requisite adhesive weight for locomotives of 3,000 horsepower, and over, owing to the small axle load of 14 to 16 tons permissible on second-class trunk lines and 16 to 18 tons on first-class trunk lines.

The Mikado high-speed engine is now used in Saxony, Prussia and Italy, and before long will be employed in Bavaria, the South German States, Switzerland and, probably, on one of the most important British railways having a maximum axle-load of little over 18 British tons on all but its first-class main line.

In Saxony, the four main rods drive on the second connected axle so that the various rods and motion parts are rather foreshortened; in Italy the four main rods drive on the third connected axle and the lay-out of the motion is on very liberal lines with low angularities. The divided drive as in the now-antiquated practice of France—originally due to F. W. Webb, of the London & North Western Railroad—is rapidly disappearing both for single-expansion and compound locomotives, it being a complication requiring the balance of parts to be effected through the intermediary of the side rods instead of effecting the balancing one axle independently of the side rods. Crank axles are now made of a form giving the required strength, longitudinally and transversely, for 5,000 indicated horse-power.

The half-tone picture shows the new Italian Mikado express engine, denominated "Nordic" type and known as "Group 746" of the State Railways. It was designed in 1919 by chief engineer of motive power Signor Luigi Greppi, Florence, Italy, but important and unique arrangements of the valve gear were introduced since the publication of the original design in June, 1920. A first order for a lot of this new type was given to Breda & Co. of Milan, Italy, in 1921-22, and in the fall of 1922 the first locomotive of "Group 746" was exhibited at the Fair of Trieste. This engine is derived from the Praire type, "Group 680" with four compound cylinders, first introduced about 1905, but with an extra pair of driving wheels. A four-wheel front truck in Groups "680" and "746" is constituted by fitting the small pilot wheels and leading driving wheels into one swiveling truck known as the "Italian" or "Zara" system. By this arrangement one idle axle is eliminated in shortening the engine and lessening its weight. The new Mikado locomotives have maximum axle loads of 16.5 metric tons, similarly to the compound Prairie type of 1905. Since that time the axle load for Pacific simples was raised to 18 tons, but only the heaviest tracks could carry them. Obviously, the most significant innovation in these new locomotives, "Group 746," is the re-introduction of compound expansion which was abandoned in 1910-11 in favor of single-expansion with the Schmidt superheater because it was then believed and as then explained officially to the present writer, that compound expansion necessitated very high boiler pressures; since then however, other European railways have re-introduced compound expansion in increasing the power of their locomotives by 50 per cent without any increase in the fuel consumption over superheated "simples" and with boiler pressures of 160-170 lbs. (occasionally 180 lbs.) so that the State Railways have been led to review their opinions and re-introduce compound expansion, starting the reversion with these new Mikado locomotives "Group 746."



2-8-2 Type Four-Cylinder Compound Locomotive, Italian State Railways

The neighboring French lines of the Paris, Lyons and Mediterranean Railway owning single-expansion superheated-steam locomotives of higher power than any existing in Europe up till 1923, had been obliged to raise the boiler pressures from 170 lbs. to 200 lbs. per sq. inch, on their Pacific type locomotives, and some Belgian and British lines employed 200-225 lbs. for single-expansion, the Italian State Railways decided on 200 lbs. pressure for the compound engines "Group 746," instead of following the Swedish State Railways example of 180 lbs. per sq. inch for compounds.

It may be here recorded as a now well-recognized fact that it was the campaign, in the engineering press, against excessive boiler pressures of 200-225 lbs. which decided the abandonment of compound expansion in most of the countries of Europe between

1905-1913. Since then, the value of the outcry, and its origin, have been recognized; and from 1913 till 1923 the railways of Europe, one by one, have been forced, by the pressing requirements of higher efficiencies and greater haulage-power on lower costs for fuel, materials and labor, to re-introduce the system after a most valuable but costly experience of the low-grade efficiency of engines which do not utilize their exhaust steam to augment their power.

All the largest and most powerful of recent locomotives in Europe, express and freight, work by compound expansion of the steam, and these are giving the highest results obtained from any engines in the world, that is, developing 30 I. H. P. per ton of loaded weight with saturated steam and 27 I. H. P. per ton with superheated steam at economical rates of operation as against the very best superheated steam, single-expansion locomotive of Europe. England and America developing a maximum of 21 I. H. P. per ton, 19 I. H. P. at maintainable power rates and 14 to 18 I. H. P. per ton at the most economical cut offs of 31 to 33 per cent.

It is now usually found that two compound locomotives develop the same power as do three single-expansion, superheated locomotives burning coal at the same aggregate rate per hour, and with the best power-production per ton of coal. Consequently, the first cost of one entire engine is saved, with its fuel and its water consumptions, its crew, and all its boiler and other parts to be maintained in repair. Commercially, it is said to be the greatest development of efficiency ever realized by any one system in locomotive engines. On the Swedish State Railways the cost of repairs have been reduced 33 per cent per annum during two consecutive years by means of compound expansion. In normal train-operation on level roads the water per I. H. P. hour is 18 lbs. for simple superheated engine and 12 lbs. for the compound; on long up-grades it is 21 lbs. for the simple and 14 lbs. for the compound. By card-measure, giving net consumption of steam entering the cylinders, it descends to 16 lbs. per I. H. P. hour for the simple and 11.3 lbs. for the compound. The latter rate approaches close to the condensing "Uniflow" stationary engines—single-expansion but not Perkins compound "Uniflows."

To show a photo picture of the new Italian compounds, after the system had been finally and definitely abandoned 12 years ago, would naturally give rise to questions as to the right mind of the present Italian State Railway engineers without the following general excerpts from modern locomotive practice. Old readers of this journal are not likely to forget the prophecy of the late Dr. Angus Sinclair as contained in his paper read at the New England Railway Club, April 10, 1889, which was translated into many languages: "If ever the compound engine becomes standard on railways in the future it will not be thanks to the negligence or the apathy of its adversaries." For forty years the anti-compound spirit has never left sentry duty, and now that locomotives with drifter valves, suitably contrived permit engines to work up to the best efficiency possible by either system—in one and the same engine, at the will of the enginemen, and at any speed, and indicate that as much as 50 per cent power increase results from compound expansion, this demonstration of its high power and economy has had the quality of embittering the old antagonism to the utilization of the power that goes to waste each time that release begins in the best single-expansion engines known.

It has been claimed that the engineering Press has, in most countries, refused to publish official documents relating to tests of new compound engines so that today most persons interested in the railways are quite in the dark concerning the most efficient railway locomotives in the world; and it now seems possible that by prolonging this struggle against information the results will never be made public.

It is an example of a complex psychology in which the engineering basis does not enter at all. This psychology is an inheritance from James Watt, who, fearing the commercial competition of more efficient engines, took out patent No. 1321, March 12, 1782 to baulk patent No. 1298, July 13, 1781. That old spirit survives still in 1923—Watt lives again in his unwitting descendants. Dr. Angus Sinclair understood that and became a prophet of the future.

Anti-compound engineers have an abhorrence of steam-autographed indicator cards and cannot be brought to look at them; but those who honestly desire to know why the railways of Europe are against their own previous antagonism, re-introducing compound expansion in millions of horse-power should study the set of cards Fig. 2 as referred to the cylinders of the new "Nordic" engines "Group 746."

In the improved high speed compound locomotives of the Italian State Railways there is one piston valve for each cylinder, and these are housed in groups of two in one valve chest of elliptical section. Each set of two valves are driven in opposite directions, for the cranks which are set at 180 degrees by a single ordinary Walschaerts gear. The two steam chests and valve gears are set outside the frames, so that they can be seen by the engineman at all times and are readily accessible. There is, therefore, no inside mechanism with the exception of the two high pressure connecting rods.

The crank pins and journals are hollow. The cylinder centers are all in the same horizontal plane, and are made in two parts. The rods are all of the same length.

In order to obtain a liberal clearance at the lowest position of the inside connecting rods, the second axle is cranked.

The initial net pressure exerted on the pistons at the dead centers is 30 per cent less than in the case of the simple locomotives having the same boiler pressure, while the mean effective pressures per unit of steam consumed is 50 per cent more.

The boiler is fitted with a firebox of medium width, a long combustion chamber, a brick arch and a superheater.

General Dimensions

Boiler pressure .... 199 lbs. per sq. in.

Cylinder diameters:

  Fed direct from boiler .... 19¼ in.
  Utilizing exhaust steam .... 28¾ in.

Piston stroke .... 26¾ in.

Diameter driving wheels .... 74 in.

Constant of mechanical tractive effort:

$$\frac{d^2 \times l}{D} = \ldots\ldots\ldots 133.7$$

In which

  d=diameter of cylinder
  l=length of stroke
  D=diameter of drivers

Constant for horse power:

$$\frac{A \times l}{33{,}000} \ldots\ldots\ldots 0.01966$$

In which

  A=area of piston

Valves, type .... Piston

  diam. high pressure .... 12 in.
  diam. low pressure .... 15⅜ in.

Distance between valve spindles, oblique .... 19⅛ in.

Distance between valve spindles, horizontal .... 14¼ in.

Radius of valve crank .... 16 in.

Steam lap, high pressure	1.54 in.
Steam lap, high pressure	1.54 in.
Exhaust lead, high pressure	.08 in.
Exhaust lead, low pressure	0 in.
Steam lead, (all cylinders)	.2 in.
Length of connecting rods	9 ft. 8 in.
Diameter crank cheeks	35.65 in.
Grate area	46.26 sq. ft.
Heating surface, firebox	181 sq. ft.
Heating surface, tubes	2368 sq. ft.

Heating surface, superheater	721 sq. ft.
Heating surface, total	3270 sq. ft.
Wheel base, rigid	12 ft. 11.9 in.
Wheel base, front driver and front (Italian) truck	8 ft. 6.4 in.
Wheel base, rear driver and trailer truck	8 ft. 10.3 in.
Wheel base, total	36 ft. 10.5 in.
Weight engine, empty	189,200 lbs.
Weight engine in working order	218,570 lbs.
Weight engine per driver in working order	36,300 lbs.
Weight engine, total on drivers	145,200 lbs.

"Nordic" Compounds

Powers, Measured by Indicator-Cards Made in Compound Operation, and in Single-Expansion Alternatively in the Same Engine, as also in Locomotives with no Alternative System of Expansion.

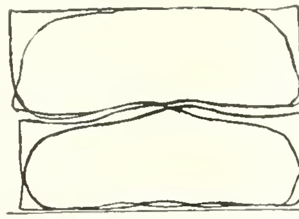
SIMPLE COMPOUND

No. 1 S. J.

Cut-off 0.78. Boiler Pressure 199 lbs.

No. 1b.

M.E.P. 174 lbs. per sq. in.
87% Boiler Pressure.
Starting Strokes (Compound working annuled). "Nordic" Class 746, tractive effort constant $\frac{d^2 \times 1}{D = 74 \text{ in.}} =$ 133.7



M.E.P. 130 lbs. per sq. in.

M.E.P. 60 lbs. × R. 2.16 = 132 + 130 = 262 lbs. per sq. in.
130% Boiler Pressure
Third stroke no live steam to L. P.

Maximum tractive efforts 1,174 × 133.7 = 23,260 lbs.

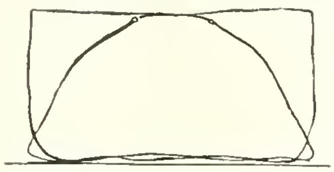
262 × 133.7 = 35,000 lbs.

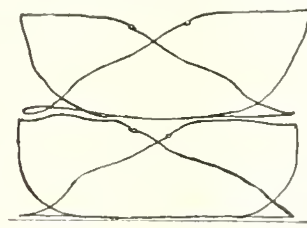
TRACTIVE EFFORTS AT STARTING WITH 180 LBS. BOILER PRESSURE

No. 1a Cut-off Limit 0.65

0.4 cut-off. 48 R.P.M. No. 2

Max. M.E.P. 154 lbs. per sq. in. 84% boiler pressure.
31 R.P.M.
Cut-offs, 0.65 simple, and 0.40 compound indicate same tractive efforts during starting strokes.
Dead Slow.





M.E.P. 63 lbs. per sq. in.

M.E.P. 38 lbs. per sq. in. × R. 2.16 = 82 lbs. per sq. in.
63 + 82 = 145 lbs. per sq. in.
80% Boiler Pressure

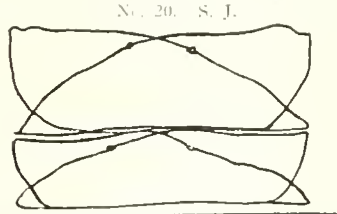
Maximum Tractive Efforts 154 × 133.7 = 20,590 lbs.

145 × 133.7 = 19,390 lbs.

No. 20. S. J.

0.6 cut-off = 169 R.P.M.

Indicated tractive effort, 180 × 133.7 equals 24,060 lbs.
I.H.P. 2,392 × 0.8 = 1,913 H.P. at drawbar



M.E.P. 96 lbs. per sq. in.

M.E.P. 39 lbs. × R. 21.6
84 lbs. + 96 = 180 lbs. 90% Boiler Pressure
169 R.P.M.

At 169 R.P.M., the tractive effort (24,060 lbs.) at 0.6 cut-off exceeds the maximum realizable when starting trains in full gear, cut-off (0.78) and exhausting steam direct to the air. See Fig. 1.

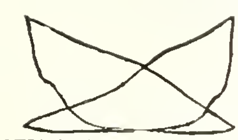
No. 16.

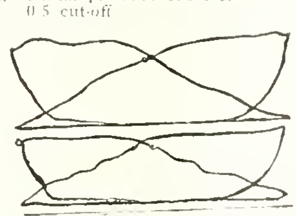
180 lbs. boiler pressure
Initial pressure 170 lbs.

Boiler pressure 180 lbs.
Initial pressure 170 lbs.
0.5 cut-off

No. 14
S. J.

M.E.P. 65 lbs. per sq. in. 130% boiler pressure.
Indicated tractive effort 8,690 lbs.





M.E.P. 64 lbs. per sq. in.

M.E.P. 29 lbs. × R. = 63

241 R.P.M. I.H.P. = 1,231
at 200 lbs. boiler pressure I.H.P. = 1,368

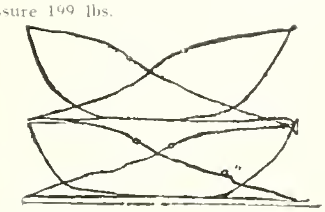
Indicated tractive effort equals 16,980 lbs.
M.E.P. 64 + 63 = 127 lbs. 70% boiler pressure. 234 R.P.M. I.H.P. = 2,337.
Probable Drawbar H.P. 2,337 × 0.7 = 1,635

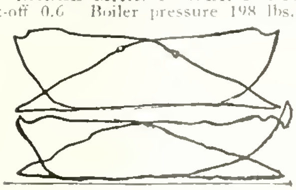
"NORDIC," CLASS 746, F.S. 1
No. 6 S. J. Cut-off 0.4 Boiler pressure 199 lbs.

PROBABLE MAX. POWER INDICATED
Cut-off 0.6 Boiler pressure 198 lbs.

M.E.P. 53 lbs. per sq. in.

M.E.P. × R. 55 lbs.





M.E.P. 70 lbs. per sq. in.

M.E.P. 28 × R. 2.16 = 60 lbs.

Indicated tractive effort 108 × 133.7 = 14,440 lbs.
R.P.M. = 245
53 + 55 = 108 lbs. = 54% Boiler Pressure

I.H.P. = 2,080

Indicated tractive effort 17,380 lbs.
R.P.M. 277
H.P. 70 + 60 L.P. = $\frac{\text{P 130 L A N}}{33{,}000}$ = 2,832 I.H.P. × 0.67 = 1,897
Probable Drawbar Horse Power

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The Mechanical Convention

Although the big mechanical conventions of the country, if not of the world were curtailed into a three days session in which the great exhibits and the multitudinous social features of the heretofore, regular event were eliminated and the technical meetings compressed into three days instead of being spread over six, much was accomplished. There were many regrets that the executive committee of the Mechanical Division felt it necessary to take the step that it did. It was feared that there would be such a lack of interest as to militate against the technical value of the meeting.

The result has been a happy disappointment of such forebodings as the character of the papers and reports reproduced in another column will prove. The individual papers bear the stamp of careful preparations while the committee reports show that a great amount of work must have been expended in their preparation.

The discussions were pointed and brought out many valuable suggestions so that the total results as they will appear in the proceedings will stand for a favorable comparison with what has gone before.

It is of course, impossible to even estimate the value of the outside meetings, the piazza convention, as it was called at Saratoga, where men have a chance to exchange experiences with their fellows. This was, at one time, looked upon as constituting the choicest tidbits of the whole gathering and what made it worth while for the average individual to attend.

As for the meetings themselves they upheld the traditions of the two mother associations, in the high character of the technical presentation of the subjects before them, and perhaps that is all that should be asked or expected of a meeting of this kind.

President Harding on Transportation

Great credit is due President Harding for the emphatic warning contained in his address at Kansas City concerning our transportation problems. He pointed out that nothing is to be gained by dwelling upon past sins and that much harm could unavoidably be inflicted upon the whole country by obdurate insistence upon programmes that amount to railroad baiting.

Everyone whose opinion is worth considering knows full well that government ownership or operation is not the solution of our railway problems and it is well that the shallow-minded reformers in and out of politics have been told that they can expect no aid or comfort from our present national government.

It may be said that his assertions are obvious or commonplace, but they are not so considered by some groups in the next Congress and it was to not a few of these that the President was speaking.

However, he apparently expects too much of the programme of consolidating existing lines into a few large systems. Fearing undue delay under the present provisions of the law he suggests legislative change to stimulate the consummation of the merger programme. Whatever may be thought of the ultimate utility or the desirability of such consolidations as are now being planned, it ought to be frankly recognized that under no conditions would it be possible both wisely and quickly to reorganize the whole financial and operating structure of our transportation system.

Car Wheels

The report of the committee on wheels that was presented at the meeting of the Mechanical Division of the American Railway Association last month is deserving of careful attention, not only because of the thoroughness of it, but because of the new features of car wheel specifications which it contains. Prominent among these specifications is the introduction of a chemical requirement for cast iron wheels. This was suggested several years ago, but was met by a very considerable opposition not only from the manufacturers but from users; the contention being that it added a new complication and shifted responsibility from the manufacturer to the user, to whom chemical composition was a matter of total indifference so long as the wheel was strong enough to do its work. Its strength was measured by the drop and thermal tests and beyond this it was unnecessary to go. And this in spite of the fact that the large foundries of railroads making their own wheels had been very careful in the selection of their charges to get a proper balance of the impurities, especially of silicon, sulphur and manganese with special emphasis put upon the silicon. It was the aim usually accomplished to keep these impurities within certain limits, but in the specifications just offered, carbon is included and its maximum is set down at 90 per cent for combined carbon out of a total minimum desired of 3.35 per cent. The reason for this is that the percentage of combined carbon indicates the effectiveness of the annealing of the wheel in the pit. Thus the advocates of a chemical specification have won the day so far as the committee's report is concerned and there is little likelihood that it will be rejected when it is submitted to letter ballot.

This matter of carbon content appears again in the recommendations for steel wheels, wherein it is proposed that shipments be so made "as to permit mating and mounting within a five-point carbon range according to the carbon content stamped upon the wheels." In the discussion it was held that this was an unnecessarily low limit and Mr. Coddington, the engineer of tests of the Norfolk & Western, presented an interesting table of flange wear based upon an elaborate investigation, showing that it was not until a difference of ten points was reached that there was a consistently greater flange wear of the low over the high carbon wheel of two mated wheels. This matter, however, is one of choice on the part of a railroad company where the range can be extended to as many points as may be considered desirable.

It was about three years ago that attention was called to the practice of one or more roads that required small lugs about ⅜ in. in diameter to be cast on the inside plate near the hub. Enough of these were to be cut off so that the number of those remaining would represent the tape size of the wheel. This was such an evident advantage in the mating of wheels and in the avoidance of retaping that it has been incorporated into the recommendations of the committee. It is the intention to have the wheels taped and the proper number of lugs cut off at the foundry, for it is especially provided that "under no circumstance are any of these lugs to be cut off after the wheel is received from the foundry."

The report fully recognizes the inconsistency of applying wheels on the basis of car capacity rather than that of gross weight. The old method of putting a wheel of a given weight under a heavy refrigerator car and a light box car because both happened to have a capacity of 60,000 lbs. for example, has been definitely discarded and gross weights alone are specified. In these the range is from 95,000 to 210,000 lbs. with cast iron wheels ranging from 650 to 850 lbs. with an allowance of 10 lbs. reduction to the minimum weight in the 650, 700 and 750 lb. wheels and 15 lbs. for the 850 lb. wheel. Overweight is, of course, allowed for, but it is to be at the maker's expense.

The tests to which the test wheels are to be subjected are the drop and the thermal as before. In the case of the 850 lb. arch plate wheel, the proposed drop test is 12 blows from a height of 13 ft. When it was suggested that this might well be increased to 15 ft. the chairman of the committee called attention to the fact that there was no recommendation that the 850 lb. wheel be advanced to standard, and added that there were some indications that the design in that weight was not yet what it should be.

There was a tentative suggestion that there is a possibility of getting better wearing results by grinding mounted new cast iron wheels, and that railroads having the facilities for doing the work, give consideration to the practice. The advantage of the practice lies in the fact that there may be an eccentricity in the wheel due to casting or mounting and that the grinding, by eliminating it, will make them run better and should reduce the number of flat spots and be easier on both track and cars.

Wheels having seams have been accepted although they were known to be dangerous, and a potent contributing cause of broken flanges. A small seam, growing by detail, often results in a derailment that may be a disaster. Because of a communication received from one of the member roads, calling attention to the present rule regarding the condemning limit for seams in cast iron wheels, and urging that a seam whenever found, should be a cause for the condemnation of the wheel, the committee has recommended that "any circumferential seam within 3¾ in. limit from flange" will be cause for the condemnation of the wheel. Certainly a move in the direction of safety and one that ought to have been taken long ago, in view of what we know of their danger.

The taper of the tread of the wheel has again come to the front. Anyone referring to the proceedings of the Master Car Builders Association prior to 1907 will find discussions on the subject, when it was proposed to sharpen the taper from one in 25 to one in 20. The American Railway Engineering Association has asked as to a possibility of a change being made, so as to have a permanent basis from which to start their recommendation for the canting of rails. They have been advised that the only recommendation that is likely to be made is that the taper be carried out to a point near the rim, making the tread of a single taper. The present change of taper is supposed to serve as a partial preventive to the formation of outside flanges, and so protect frogs and switches.

The gauge known as the I. D. Service Metal Wheel Gauge has been recommended for wheel inspection. It seems to serve about every purpose that a gauge can be called upon to perform. It will measure the thickness of the rim and flange. It will show the amount of metal to be removed in order to build up a standard flange on a worn wheel. It will check the location and measure the depth of the witness groove in a flange. It will measure the length of flat or shelled-out spots in the tread. It will measure vertical flanges and chipped rims. It has, therefore, rightfully been considered as the equivalent of the A. R. A. gauge.

These are some of the salient features of this important report, and its committee fully deserved the unanimous rising vote of thanks that was tendered it at the end of the discussion.

Determining Relative Value of Coal and Fuel Oils for Locomotives

The International Railway Fuel Association is investigating the relative value of various locomotive coals and fuel oil available for locomotive use. As it is well known, the relative value of solid and liquid fuels is not represented by their comparative B. T. U. content, principally because the standby losses with fuel oil are very much lower than where coal is burned. Coal burning locomotives ordinarily arrive at terminals with a considerable quantity of partly consumed fuel in the firebox and coal is also consumed while locomotives are standing at stations and on side tracks whereas only a small quantity of fuel oil is required under similar conditions. The results of this investigation which are to be presented in the form of a paper at the next annual meeting will be of particular value to the railways in determining the relative prices they can afford to pay for coal and oil fuels. This will also establish the true relative fuel efficiency of railroads burning fuel oil in comparison with the coal burning roads. The Interstate Commerce Commission now requires railways burning fuel oil to report the equivalent consumption of coal per freight ton and passenger car mile on the assumption that 3½ barrels of fuel oil is equivalent to one ton of coal.

The International Railway Fuel Association has further planned to make the extensive study of locomotive fuels being mined in various parts of the country and will present at its next annual meeting a symposium on methods best adapted to utilize such fuels as are now available. This will relate particularly to the availability of lignite, peat and other low grade fuels for locomotive use. The Association also contemplates an investigation of the interrelation of the numerous fuel economy devices now available. The result of this investigation which will be presented at the next annual meeting will show the savings that can be anticipated from a combination of several locomotive fuel economy devices such as the brick arch, superheater, feed-water heater, syphons, etc. The facts to be developed in this report are of real importance to the railways since the use of several of these devices in combination is becoming quite general.

The Mechanical Division—Its Future is Bright

By W. E. SYMONS

Some few short sighted pessimists went into mourning when the American Railway Master Mechanics and the Master Car Builders Associations were with certain other railroad associations merged into and became an integral part of the American Railway Association during government control, and now that a real sure enough genuine business meeting has been held at the most central geographical point and largest railway center in the United States, with an entire absence of any other features to detract from the actual business of the division, thus making it possible for railway officers to do the things they are there to do, some few have gone into sack cloth and ashes and are loudly bewailing the passing of the old order of things and predicting a dark future for the Mechanical Division, while a great majority welcome the advent of business methods, which have already shown wonderful economic results and will no doubt in future add much to the value of the division to railway interests.

Proper Place to Hold Mechanical Convention

In recent years there seemed to have been so little opposition to holding annual conventions, with their elaborate and expensive exhibits and social features, at Atlantic City, that many seemed to rest secure in the belief that this was a permanently fixed programme, while not a few openly expressed the view that this was really the only place where a successful convention could be held and this fallacious theory has had much to do with the increased burden of expense, and in no small measure detracting from their usefulness.

Let us briefly review the growth and meeting places of these associations:

The American Master Mechanics Association was organized and held its first meeting in Cleveland, Ohio, in 1868 at which time there was in the United States about 50,000 miles of railway.

The Master Car Builders Association was organized and held its first meeting at Altoona, Pa., in 1867, at which time the mileage of the railways was substantially as above.

During the period of their existence these associations have held sessions in about 20 of the principal cities in the United States east of the Rocky Mountains, and for the past 34 years have met and worked together jointly. It may be mentioned that the Master Car Builders met in Dayton, Ohio, the year of the Master Mechanics first meeting in Chicago in 1868, but the Master Car Builders met in Chicago the next year, 1869, and the two associations as Mechanical Division five of American Railway Association finally return to Chicago as one body after 54 years, representing more than 250,000 miles of railway, 66,700 locomotives, 2,380,000 freight cars and 55,700 passenger cars.

Of the 20 or more cities in which the associations have met two of these have been favored with several return sessions. Saratoga Springs was selected as the meeting place nine different years, while Atlantic City has until 1923 been the meeting place since 1906, or about 17 years.

Atlantic City as a pleasure resort has few equals in the world, but the railroad business and matters subject to conference between the officers in charge is so far removed from the scope of worldly pleasures, that the selection of a proper meeting place for the mechanical officer of the railways of the United States, Canada and Mexico, for the transaction of important business, at once suggest a more central point. The great waste of time, human energy, and enormous expense of these conventions, which in the last analysis is paid by the railroads, has been a matter of grave concern to certain railway executives for many years past, and has furnished much material for the anti-railroad muck-raking political propagandists who publicly charge the railways with continually wasting millions of the revenue or toll taken from the people, and have effectively used this indictment in magnified form to prevent the railways from securing many concessions they justly deserved from regulatory or legislative bodies.

In addition to their own personal observations, certain railway executives arranged with a specialist to make a study of the situation and submit report with recommendations as to remedial measures to correct certain defective features, reduce extravagance and waste and improve the value of the association as a whole.

The substance of this neutral specialist's report, which was concurred in by many, is as follows:

"First: I wish to subscribe to the great potential value of these conventions, including the exhibits, from an educational standpoint, and of the fine type of the great body of railroad men for whose benefit and their employing companies, these conventions are held.

Second: Having thus in a general way, committed myself to the value of these conventions and of the splendid type of men who arrange, conduct and attend them, it is quite proper to come to the point and be specific as to certain features subject to criticism.

Great Waste in Expenses

The cost of these conventions to the railways and supply companies run into enormous figures, amounting in the aggregate to many hundreds of thousands of dollars, a large portion of which is actually *wasted* for the simple reason that the actual work of the conventions is handled by less than 20 per cent of those who attend, and this small minority, owing to the above fact, cannot find time to properly inspect and study the exhibits, and it is this particular 20 per cent who should above all others have ample time to thoroughly inspect and study the exhibits. The educational value to this 20 per cent would be much greater than to the other 80 per cent. Consequently, there is a great waste to all parties at interest.

The social features of these conventions have grown to such an extent as to be an actual burden upon, and detract from the efficiency of many of the real convention workers, and also add enormously to the expenditures of the exhibitors. As an illustration, the president of a certain supply concern recently said, "I dread the conventions and wish they were put on a strictly business basis, for we have a good size sales organization, every man of whom says he must be authorized to take his family, stop at the best hotel, have an unlimited expense account to entertain his customers and their families in every known way, also an expensive exhibit to be shipped and reshipped once each year; otherwise a good showing cannot be made on sales, with the result that the expense of this convention alone may wipe out an otherwise profit on the year's business, and practically commits us to try and outdo both ourselves and our competitors at next year's conventions."

Such rivalry in an organization, and between competitors in trying to influence business, means the loss of many thousands of dollars that in the last analysis must be and *is paid* for by the railways, either in the form of *higher prices* or an *inferior product.*

Geographic Location Not Good

A glance at the map, and the application of ordinary business judgment would suggest a more central location. Atlantic City is the playground of America. For the owners of railways, the bankers who finance them, or committees of executives who define policies of management it is to my mind an ideal place to meet, as most of these gentlemen reside along or adjacent to the Atlantic coast. But as a regular annual meeting place of the mechanical officers and display of exhibits on their present scale, it is thought by many to be the most unbusinesslike proposition imaginable.

But some say the railroad game is a hard grinding process, relief from which should come at least once each year with privilege to go where and do as one sees fit, and to this proposition I most heartily assent, with the provision, however, that the time should be spent in the most advantageous way for both parties interested. As an extreme case, and to emphasize this point, why should railway officers on the Pacific coast, who may justly deserve and badly need several days rest to recuperate lost vitality, be either required or allowed to make a still farther drain on their fagging energies, by riding 3,000 miles in heat, dust and cinders, then put in a week or ten days under the highest physical and nerve tension, then another 3,000 mile ride in heat, dust and cinders finally arriving at home in a much worse condition than when leaving home (although few care to admit this fact), when Lake Tahoe, Catilina Island, and numerous other health resorts and rest retreats are not only within a few hours ride, but if patronized would effect a remedy in less than the time required to ride 3,000 miles by rail.

Suggested Remedies

Arrange the conventions on a strictly business basis, with absolutely *no* social features, exhibits or exhibitors. Hold this convention in Chicago or at some summer resort hotel nearby with ample accommodations for all who should attend, and pass the word along that all whose presence is not required will be "*Persona Non Grata.*" Commence business Monday at 9:30 A. M.; hold two sessions each day and get through Friday noon, having accomplished much more than is ordinarily done in two weeks.

A program of this kind would not only bring joy to the heart and relief to the mind of many of the leading railway and supply men, but at the same time serve as a gentle and effective rebuke to those of either class, who have by acts of omission or commission commercialized these conventions, thus detracting from their real value. It would also result in saving several hundred thousand dollars.

A permanent remedy really means a permanent home, and not only for these conventions and the exhibitors, but should include many other allied interests.

The railways are well able to, and might well consider the erection of a building to be devoted entirely to transportation interests and things pertaining thereto.

The ground floor should have many tracks for cars, locomotives, steam shovels, ditchers, etc., with wings, bays, extensions, etc., for temporary and permanent exhibitors of all known machines, materials, or devices used on, or in connection with railway construction, operation or maintenance. There should be special provisions for the motor truck and aerial department, which are potent factors in transportation, are here to stay and must be reckoned with.

The mechanical engineers, civil engineers, hydraulic engineers, mining engineers, automotive engineers, electrical engineers, marine engineers, aviation engineers and other scientific bodies of similar standing should be invited to coöperate in the proposition, establish headquarters in the building, holding periodic and annual meetings there.

To this building the mechanical conventions and other railroad associations should go as a permanent home, there being ample provisions for conventions, conferences of all kinds, committee meetings, demonstrations and possibly tests of certain devices or apparatus.

The ground floor and probably the next two floors could at once be occupied by well known and reliable manufacturers of railway equipment and supplies, making this their permanent Chicago office, always available and convenient for any railway man. The upper floors would be sought by a desirable class of office tenants and the combined income would in a short time make it a self-supporting proposition.

Such a building should cover a ground area of, say equal to one full city block, with office portion 12 to 15 stories high and would cost several million dollars. It should, of course, be designated by some suitable title or name befitting such a structure, as it would in a short time become both nationally and internationally known as the "Transportation Bourse," or "Clearing House."

Let us assume that the head of Mechanical Department of a large trunk line is preparing a budget of next year's expenditures, which includes a new shop with several additions to old ones, and of course new tools. Obviously much of it is joint work with the Chief Engineer, as it involves buildings, tracks, and structures. Instead of corresponding and shopping around separately, not infrequently overlapping or duplicating each other and holding the whole thing open to "see the new exhibits at the June conventions at Atlantic City, these two department heads, together or singly, could bring such of their staff as are actually needed to the "Transportation Bourse" in Chicago, and in one day accomplish more than would ordinarily be done in two weeks' time, and at a cost so trifling as to be incomparable. Then when the mechanical conventions were held, the number of officers from this line in attendance, would be governed largely by committee assignments to the subject handled, and operating conditions on the line.

It would appear that the Chicago convention was not only planned but carried out to some extent on the foregoing lines, and as to whether the other features of an engineering or transportation building with permanent exhibits, and a permanent home for this and other associations, societies, etc., will be acted upon or not remains to be seen.

But some say, yes many say, the hall was hot, poorly ventilated and the acoustic properties bad, and in this they are right for all of these discomforts combined resulted in a most disagreeable session to many, including the writer, but these disadvantages can be remedied right in Chicago without going 1,000 miles from the proper geographical meeting place for Division five and most all other National Railway Associations.

The Future Is Bright

The brightest star in the railway constellation or group, is that of the Mechanical Division. It will continue to grow in its scope of influence and usefulness, functioning as a leader in all branches of railway engineering which has to do with the continued progress of the greatest transportation system in the world.

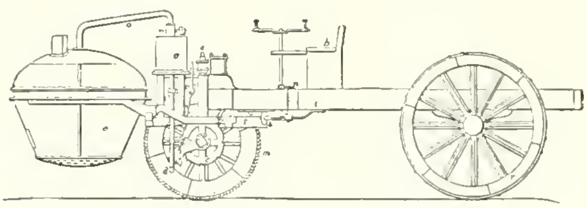
Outline History of Locomotive Development

By S. M. VAUCLAIN, President, Baldwin Locomotive Works

Individual Paper to the Mechanical Division Meeting of the A.R.A.

Transportation, however, has been and always will be a governing factor of prosperity. Those countries favored with superior transportation facilities will, other things being equal, prosper to a much greater extent than those where such facilities are more or less limited. Railway transportation has made the United States what it is today. Practically all other forms of transportation have been superseded, and many of the water systems of transportation formerly in use have been abandoned. Quantity and quality are the constant cry and can only be met by superior equipment which the science of railway engineering has made possible for the great railway systems of our country to employ.

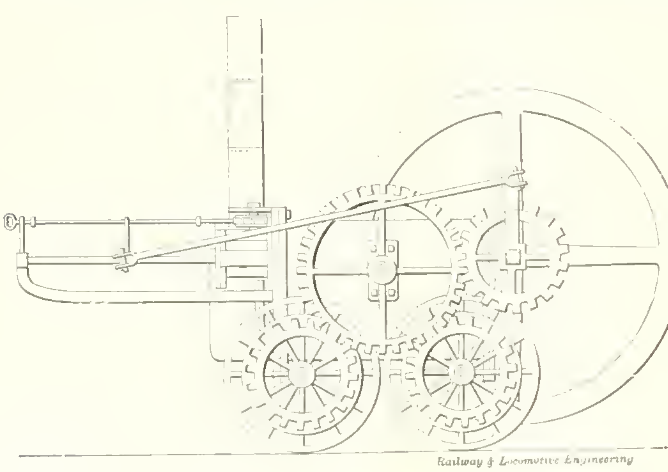
As far as is known, the first vehicle to be actually propelled by steam was a gun carriage built by Nich-



Cugnot's Steam Carriage, 1771

olas Cugnot, in Paris in 1771, while the first locomotive designed to run upon rails was built in 1803 by Richard Trevithick, a name that is still associated with the locomotive industry in England; a name that has received distinction as well in other countries, principally Egypt and Japan.

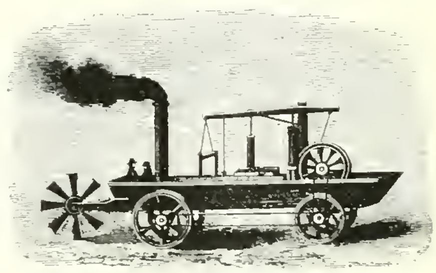
Strange to say, the first successful effort in locomotion by steam in America was the "Oructor Amphi-



Trevithick's Locomotive, 1803

bolis," constructed by Oliver Evans in the city of Philadelphia in 1804. Mr. Evans' shops occupied the ground on which the United States Mint now stands; a site now surrounded by the buildings of the present Baldwin Locomotive Works, operating night and day, continuing the industry originated by Evans on this very spot. This locomotive was really a dredging scow designed to run on land or water, but principally to navigate the rivers between which Philadelphia lies. In order to get it from the factory to the river it became necessary to use it as a locomotive that would operate on the streets and without rails to guide it. Its performance was successful, but its utility questionable.

It would be useless to attempt to trace the development of the locomotive in foreign lands, as a more



Evan Oructor Amphibolis, 1804

complete understanding can be had in this short time by reviewing briefly the progress made in the development of this country.

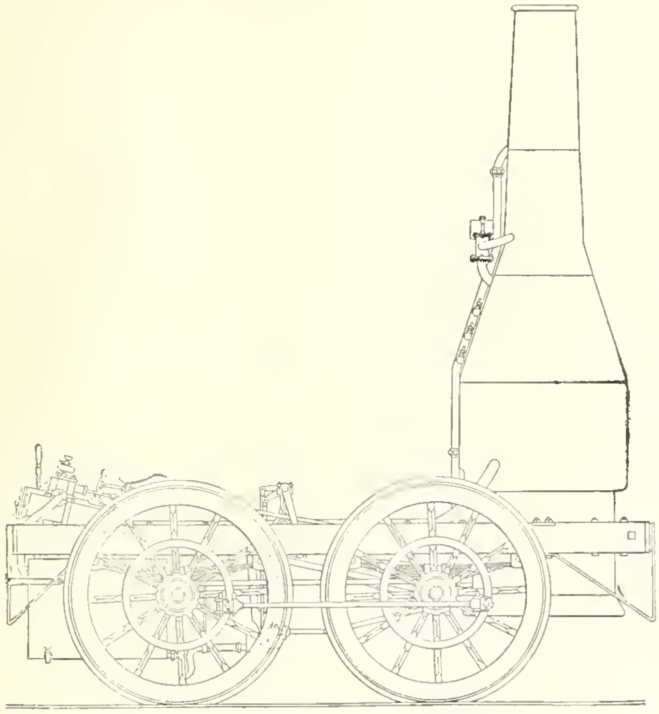
Mention should be made, however, of the first locomotive with a horizontal multitubular boiler, built by Seguin in France in 1827; and also of the famous "Rocket," constructed in England by George Stephenson in 1829. This locomotive was awarded the prize in a contest on the Liverpool and Manchester Railway. It was the first locomotive to combine three basic features which are still universally employed, viz.: a horizontal multitubular boiler, pistons directly connected to the driving wheels, and the use of the exhaust steam, which was discharged up the stack, to furnish a draft for the fire, and thus make possible the generation of large quantities of steam in proportion to the size of the boiler and draft intensity.

The various experiments and attempts in this early period to apply steam locomotives to the uses of transportation in the United States were more or less successful. Those of foreign construction imported for the purpose gave results that were sufficiently satisfactory to interest the brightest engineering minds in the country and influence them to attempt the construction of American-built locomotives. The first locomotive to be used in the United States, however, was built in England and was named the "Stourbridge Lion." It made a few trips on the Delaware and Hudson Canal Company's road at Honesdale, Pa., in 1829, but was considered too heavy for the track and bridges, and was soon withdrawn from service.

The first locomotive actually built in America was the "Tom Thumb," designed by Peter Cooper, a merchant of Baltimore, and used experimentally on the Baltimore & Ohio in 1830. It was about the size of a hand car, but it demonstrated the practicability of steam as a motive power. Then came the "Best Friend," the first locomotive built for commercial purposes in this country, constructed in 1830 at the West Point Foundry in New York for the South Carolina Railroad. This engine was very successful for about seven months, when its boiler unfortunately exploded.

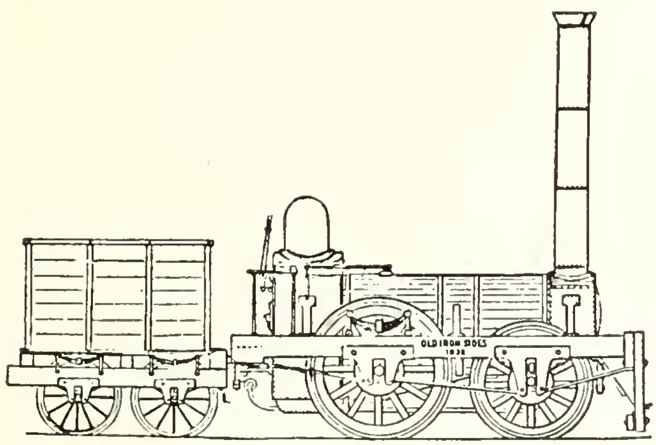
because the fireman became annoyed at the blowing-off of steam at the safety valve and weighted down the lever to ease his mind.

"Old Ironsides" was built by Matthias Baldwin and put in service in 1832 on the Philadelphia, German-



The Best Friend, 1830

town & Norristown Railroad. Its weight was five tons. It was built under great difficulties. Its operation, all things considered, was very successful. It was quite a while before the officers of the company would permit this locomotive to go out in the rain; on rainy days horses were used, but one day it was caught out on the rails when the rain descended, and proved its utility to operate under such discouraging

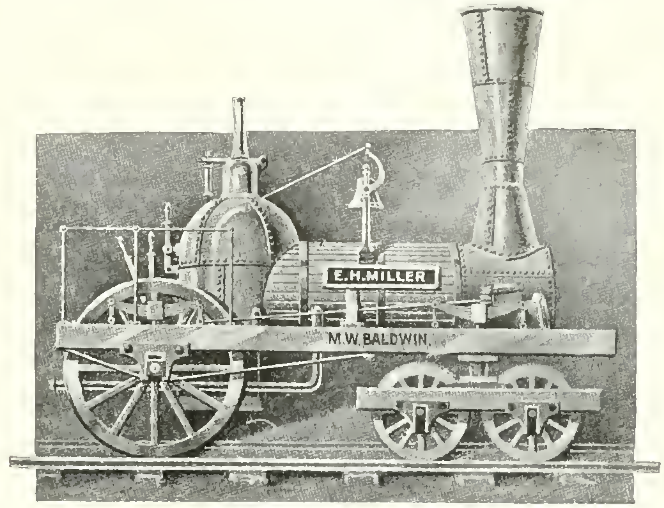


Baldwin's Old Ironsides, 1832

circumstances. The American locomotive has been out in the rain ever since. It will be noted that "Old Ironsides" had its driving wheels ahead of the firebox, withone large pair of carrying wheels supporting the front end of the engine. This added greatly to its adhesive qualities.

The further development of the locomotive by Mr. Baldwin led him to introduce a four-wheeled truck, and in this design the driving wheels were placed behind the firebox, which materially reduced the adhesion for traction purposes. The truck had first been used by John B. Jervis in 1831, and it provided the flexibility of wheel-base so essential to locomotives that operated on the sharp curves and uneven tracks of that period.

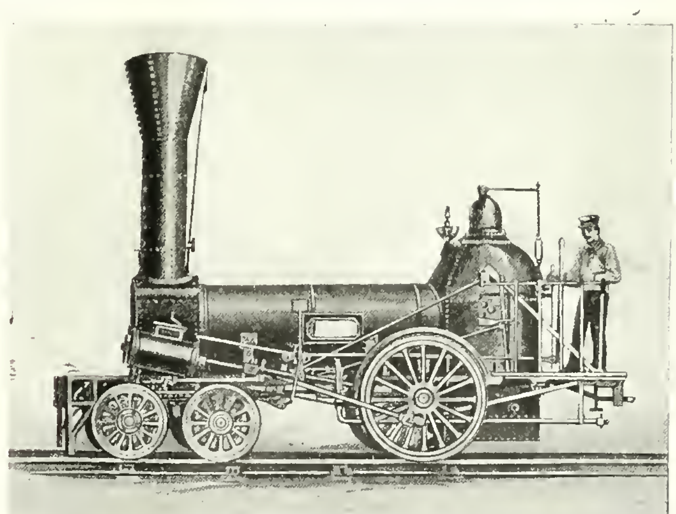
The engineers of that day seem to have realized the benefit to be derived from high pressure steam, and



Baldwin's Engine, 1834

when Mr. Baldwin introduced ground metallic joints in place of canvas and red lead joints for steam pipes, he opened the way for those who were to follow him in future and employ still higher steam pressure.

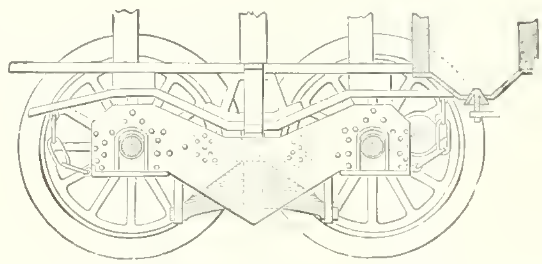
About this time the Norris Locomotive Works were established. Mr. Norris succeeded in building a locomotive of the same total weight as Mr. Baldwin's engine but of greater hauling power, by using a four-wheeled truck and placing the driving wheels in front of the firebox, so that a greater portion of the weight of the engine was utilized for traction. The next logical step in locomotive development in order to gain power was to use two pairs of driving wheels,



Early Norris Locomotive

placing one pair in front of the firebox and one behind it. This was done by Henry R. Campbell in 1836, who designed the first American (4-4-40) type locomotive, and had such a machine built by James Brooks of Philadelphia. This locomotive had no equalizing beams between the two pairs of driving wheels and, therefore, did not perform very satisfactorily. In 1837, however, Garrett & Eastwick of Philadelphia built a locomotive for the Beaver Meadow Railroad, and introduced an equalizing bar between the two pairs of drivers, which device was patented by Joseph Harrison, Jr., who later became a member of the firm known as Eastwick & Harrison. Quick to perceive the value of this device, Mr. Baldwin was so pleased with it that he purchased from Eastwick & Harrison the right to use and apply it to all the locomotives he might thereafter build.

Mr. Baldwin, ever, aggressive, felt that for moving the heavy traffic which the railways then were called upon to handle required locomotives of greater power than any previously built. He conceived the idea of a flexible beam truck which would enable him to build locomotives with six coupled wheels. Such locomotives were put in service in 1842, and in the year 1846 had grown into a design using eight coupled drivers, the first two pairs being combined in the flexible truck. The largest locomotives of this type



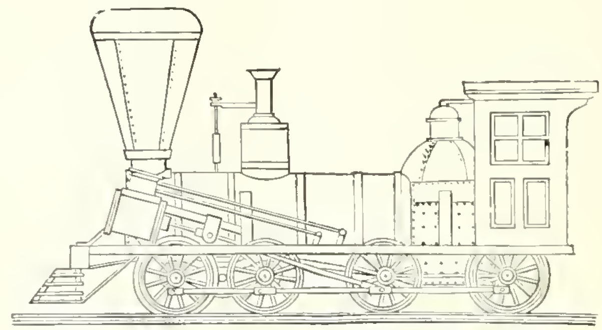
Baldwin Flexible Beam Truck

weighed about 30 tons. Ross Winans, of Baltimore, in this same year produced a locomotive with four pairs of drivers coupled, but very compactly grouped and held in a rigid frame. It is therefore doubtless due to his courage that there was introduced and generally adopted the rigid frame construction now employed in our most powerful locomotives. The most notable of these Winans locomotives were the famous Camel engines, which were among the most powerful freight haulers of their day and were built in large numbers up to 1860.

In the late '40's and early '50's the public desire for more rapid passenger service led to the employment of large driving wheels for this class of transportation. Mr. Baldwin, first in the field with the "Governor Paine," gave great impetus to the desire for better passenger locomotives. James Millholland, of the Philadelphia & Reading Railway Co., whose work in the development of the locomotive will pass down into history, in 1852 constructed for that railway passenger engines having driving wheels 7 feet in diameter. In detail of design, the Millholland engines were undoubtedly among the finest of their time.

"The Tiger," built by Mr. Baldwin in 1856, for the Pennsylvania Railroad Company, was one of the most successful passenger locomotives of that period. It used wood for fuel and its total weight was some 28 tons. In this same year an engine of this type was built for service in the South and is still working every day at Valdosta, Ga., being in its sixty-eighth year. It may be worth while to mention that this locomotive was born the same year as the speaker, and like your humble servant, while showing somewhat the ravages of time, is still able to make some smoke.

During the period of the Civil War almost anything that would run on wheels in the shape of a locomotive was acceptable. Many remodelings were made of antiquated structures, and locomotive designers became quite as numerous as the locomotives themselves. John P. Laird, at the Altoona Shops of the Pennsylvania Railroad Company, was most active,



Baldwin Eight-Coupled Locomotive, 1846

and some of his improvements, as for instance the Laird guide, exist today. Much was accomplished, and during the years intervening some of our railway systems began to consider standardization of their power. This was most consistently and determinedly put in force by the Pennsylvania Railroad Company, and the changes of types on that system, while made regularly in order to keep abreast of the times, have always been given the most conservative consideration before adoption.

It was not until 1877 that interest was taken by the Philadelphia & Reading Railway in locomotives to burn the refuse anthracite coal then produced in large quantities at the mines, and for which no market was available. The first locomotive of this character was designed by John E. Wootten, of the Railway Company, and was quite successful. It was at that time considered quite an innovation; but owing to the increased demand since made upon the steam generators of locomotives, the use of the Wootten boiler has developed what is known as the wide firebox boiler, now used with all kinds of fuel and in all classes of service. The Wootten design was a great departure and in my opinion did more for development and increased locomotive power than any other improvement of that period. It was quite a while before the merits of this construction were acknowledged, but it is now universally used.

The desire for high speed with large trains where great tractive power was not necessary, led to the introduction, in 1894, of what is known as the Atlantic type locomotive, built to meet the requirements of the Atlantic Coast Line. This type was so successful that it became almost universally employed in passenger service, though under various names such as the Central Atlantic type, Chataqua, etc. The underlying principle in each case was the same, namely, the use of the trailing wheel to carry the excess load involved by the employment of a boiler of exceptional steaming capacity and having a deep firebox suitable for burning bituminous coal.

The increased requirements of transportation, i. e., sustained high speeds with heavy trains, produced what is now commonly known as the Pacific (4-6-2) type locomotive, which is in general use throughout the country for heavy passenger service. For the heaviest class of service on steep grades, the Mountain (4-8-2) type is now being successfully employed.

The first so-called Consolidation type locomotive, built by The Baldwin Locomotive Works in 1866, was named in honor of the consolidation of the various small railway lines now comprising the Lehigh Valley System. It was a great success, and upon the same principles, Consolidation locomotives of enormous size and great efficiency have continued to be built.

About the year 1889, American locomotive designers became deeply interested in the compounding of locomotives. A considerable number of compounds of various types had been built and operated abroad. Almost any single expansion type then constructed was capable of having compound cylinders of some design applied, resulting in a more economical performance. Among the various types in use abroad were four-cylinder Mallet locomotives, originally designed for light service, and later built in large sizes for use in Russia. The first locomotive of this type built in the United States was purchased by the Baltimore & Ohio Railroad Company, and had two six-coupled units. It was exhibited at the St. Louis Exposition in 1904, and later operated very successfully in mountain service. But inasmuch as this was a single locomotive, the type did not receive the attention or create sufficient interest among railway managers to come quickly into general use; and it was not until 1906, when Mr. James J. Hill, of the Great Northern Railway Company, purchased five of these engines on my recommendation, that wide-spread interest in the type was created. In order to get a proper estimate of their value, he isolated them and placed them on one section of the road, removing the locomotives of all other types. These locomotives were equipped with leading and trailing trucks, but in other respects were of the same type as the locomotive that had been previously constructed and put in use on the Baltimore & Ohio Railroad. The experiment was successful and Mallet locomotives for steep gradients or extreme conditions of traffic became popular and are still in general use.

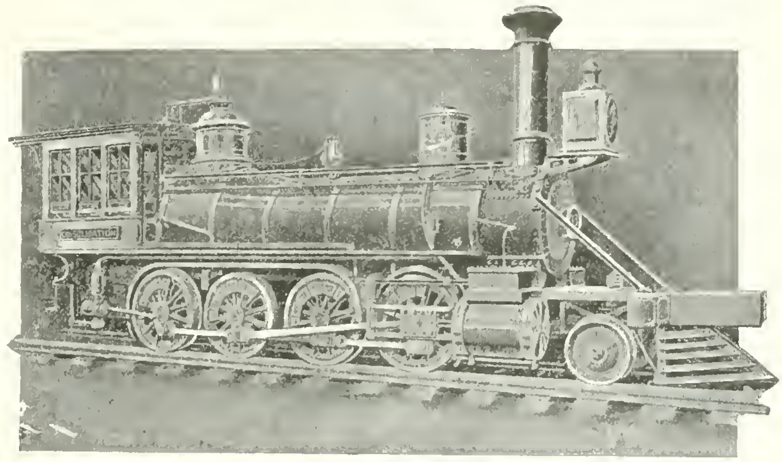
Not withstanding the fact that compound locomotives proved their economy and gave wonderful results, so far as economical consumption of fuel in freight service and high speed hauling power in passenger service were concerned, owing to the clearance limits prescribed, the constantly increasing size of locomotives made the use of compound cylinders more and more difficult.

The use of superheated steam about this time, however, enabled engineers to produce locomotives almost, if not quite, as efficient as the compound locomotives had proven themselves to be, and to still further enlarge the size of units, increase their power and maintain a most satisfactory performance.

In this connection, mention should be made of two types of locomotives which have proved particularly successful in heavy freight service. These are the Mikado (2-8-2) and the Santa Fe (2-10-2). In both of these the trailing wheel principle as originated in the Atlantic type, has been applied for the purpose of providing increased boiler capacity. Furthermore, in freight and pushing service there is an added advantage in the trailer, as it provides a guide when running backward. Largely for this reason, the Mikado type has proved a great success in meeting the special conditions found in logging and certain other classes of service where it is frequently necessary to back into sharp curves and switches.

The standardization of locomotives by the Railway Administration was of great benefit, as the consideration of the designs resulted in a much closer intercourse and exchange of thought among motive power men than could have been obtained in any other way; and while none of the classes then developed will be continued in their entirety, many of the more recent locomotive designs have as their bases the Administration locomotives.

There has at all times been an unceasing effort on the part of railway managers to use locomotives not only of greater capacity, but also of greater economy. Determined and loyal support has been given to every invention or contrivance intended to improve the efficiency of the locomotive and thus enable it to accomplish more work. To one who has given his whole life to this work and who has had opportunity to note the changes made from time to time in locomotive designs and appliances, the modern locomotive may be looked upon with some satisfaction; but also with a realization that the end has not been reached, and that the inventive genius of the future motive power experts will considerably change its form and increase its durability, efficiency and economy.



The Original Consolidation Type Locomotive, Lehigh Valley Railroad, 1866

When the Giffard injector supplanted the pump for forcing water into the boiler, it proved a feed-water regulating device that enabled an engineer to operate his locomotive with absolute confidence. Now these same wonderful devices are being replaced by feed-water heaters and purifiers operated by exhaust steam. Can we not expect in the near future an improvement that will purify the water before it enters the pump and thus prolong the life of flues and fireboxes?

When the size of locomotives had grown beyond the endurance power of the fireman to supply coal in proper quantity, the mechanical stoker came into play not only to relieve him of this back-breaking recreation, but also to supply the requisite amount of fuel and in a proper manner mechanically to the firebox. The superheater, the mechanical stoker, the feed-water heater and the power reverse gear are now absolute requirements on the modern high duty locomotive. The American firebrick arch in its perfected form, a perfection that has required some fifty years to accomplish, is indispensable.

The trailing wheels under our large locomotives, some of them carrying as much as 60,000 pounds of weight, have suggested the use of what is commonly known as the "Booster." This mechanical contrivance is simply a small steam engine attached to the locomotive trailing wheels, automatically controlled so that the weight carried by the trailing wheels can be utilized for starting of heavy trains or the overcoming of short grades which govern the tonnage that can be hauled over certain divisions of the road. By this means trailing wheel locomotives in many classes of service can be made much more remunerative in their operation than when not so equipped. The introduction of this device is becoming very general and it will probably be largely used in the future.

For many years the locomotive has been considered by the layman the most extravagant steam user and coal burning device in existence. This is entirely erroneous. The Pennsylvania Railroad System at the present time is having built 475 locomotives, as shown on the screen, with a tractive power of 87,000 pounds, equipped with mechanical stokers, fire brick arches, feed water heaters and superheaters of the most advanced type. The cylinders are operated at half-stroke cut-off when developing full tractive power, and the coal consumption per horse power by actual test is equal to that of some of our best electrical power houses where turbines and condensers are employed, namely an indicated horse-power-hour for 1.83 pounds of coal. Every user of locomotives should examine carefully the construction of these engines. Notwithstanding the fact that they carry 250 pounds of boiler pressure, there are many features employed worthy of general adoption. The high boiler pressure and half-stroke cut-off are also employed in a single expansion articulated locomotive, built by the Pennsylvania several years ago for heavy mountain service, which has given most satisfactory results.

A successful effort is now being made by railway managers to increase locomotive mileage by increasing the length of runs, and on a number of roads, notably in oil-burning districts, passenger trains are being run over five, six or seven hundred mile divisions without change, except as to engine crews. One of the important factors responsible for the success of this method of operation is the use of hard grease as a lubricant, as this has eliminated much of the "oiling around" formerly required of the engineer.

It has not been my intention to omit any of the wonderful achievements attained by the designers of locomotives in the various sections of the country, or to overlook the exceedingly satisfactory and high grade productions of other locomotive establishments. My effort has been to illustrate to you all as briefly as possible the rapid advancement in locomotive construction during the past ninety years, or during the life time of The Baldwin Locomotive Works; and naturally, many of the illustrations I have shown have been selected because of my greater familiarity with them.

Locomotive development during the past 90 years has been due entirely to the constantly increasing demand of business for better and cheaper transportation. The railway systems we now enjoy have been made possible by the enterprise of our pioneer railway builders of the past, who were courageously supported financially by the public as investors. The people of the United States quickly realized the prosperity that would follow the Iron Trail. Foreign investors were quick to absorb our railway securities and the 20th Century found us far better equipped with transportation facilities than any nation in the world, as we had better service, greater safety, cheaper rates.

The requirements of a great nation had been met by the energy, the inventive genius, and splendid operating ability of those in command. This prosperity was naturally noticeable and perhaps in excess of that pertaining to other industries, in consequence of which the economist proceeded to get busy. The political aspirants to fame seized upon the opportunity offered for establishing some very serious opinions among our business friends. The regulation of transportation, as to quality of service, methods of accounting and regulation of rates were soon paramount considerations and indulged in not only by our National Legislators, but by State Governments as well. The transportation horse was well curried but poorly fed, and soon its bones were more in evidence than before so called scientific management and regulation had been introduced.

What was intended for regulation in many instances proved to be strangulation, but by superhuman effort our great transportation lines were maintained equal to our business requirements. Terminal facilities had been perfected, the right of way made staunch and secure, by using new bridges, heavier rails and all other underlying requirements for the operation of maximum cars and locomotives, both passenger and freight. The steel passenger car and the steel freight car were absolutely necessary to provide the safety desired by the public, which in turn made it imperative to produce the present modern high duty power houses or locomotives now being made, without which, railway operation today would be impossible, and the general business of our country be reduced to but a fraction of what we now enjoy. We will omit the General Wreckage caused by recent government control.

The large expenditure of $1,540,000,000 this year by the Railway Systems of this country to perfect and provide facilities to enable the general business of the country to proceed without interruption, is well known by all. A further reflection shows that an annual increase of 7 per cent in our requirements, will during the next ten years require at least a 7 per cent increase in railway construction and equipment in order to keep abreast of the demands of an exacting public. In other words, an expenditure of approximately $1,500,000,000 must be made annually during the next decade if we are to have dependable and proper service.

Over four thousand new locomotives will be placed in service by our railway this year, capable of developing in the aggregate over 10,000,000 horse-power.

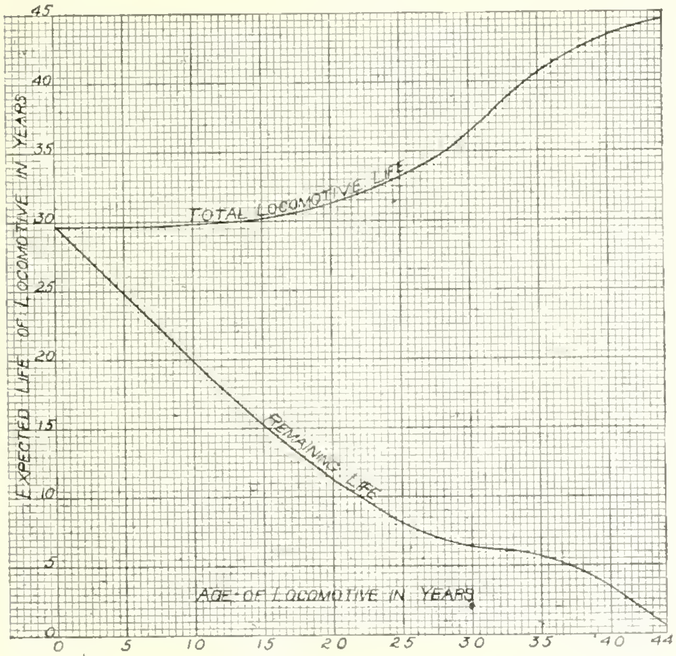
The time has now arrived when public opinion regarding the railway transportation systems of this country and the operating devices employed thereon must be put straight. There should be a campaign for the dissemination of information and facts concerning terminal facilities, extension of lines, and reduction of delays, also as to the improved mechanical appliances, that are vitally necessary to safety and service, not alone applicable to locomotives but also to other equipment, and the facilities that must be employed to maintain and keep in proper repair the modern high duty rolling stock in service, so that once more the general public will have confidence in the various railway organizations and will point to their accomplishments with a great degree of pride. It is conceded by the entire world that in this country we have the highest perfection in railway transportation, but the general business of the country cannot progress faster than its transportation facilities will permit. The productiveness of our farms and workshops will go for naught if we do not have more efficient and more rapid facilities for the distribution of our products. The fundamental of prosperity is work, and work means that the producers of transportation are public servants whose business it is to serve the farmer and the producer, and those who are engaged in serving the transportation companies with all their numerous requirements, from steel spikes to locomotives, cannot expect increasing business unless transportation facilities are at least equal to or in advance of transportation requirements.

The way to increase prosperity is to increase our general business, and to promote our transportation facilities and various public utilities by confidence and financial support, coupled with the creation of more efficient and economical devices in transportation equipment. We must all do as your speaker has done, go out into the highways and byways of business, and speak to our business friends, encourage them to address their associates and workmen as to the necessity of abandoning the demagogue, political or otherwise, and to create among the general public a return of confidence in the vast army of Transportation Managers now responsible for the future of our country, and to become stockholders in all public utilities that contribute to our greatness, and especially the American Railway.

The Life of a Locomotive

A Mortality Study Based on an Analysis of Over 8,000 Locomotives on Nine Railways

The accompanying mortality table of locomotives has been compiled on the same basis as that used by life insurance actuaries in the compilation of a similar table for human beings. It is based on an analysis of 8,165 locomotives on nine western railroads. The study was made by F. H. Adams, mechanical valuation assistant on the Atchison, Topeka and Santa Fe and reported to the Bureau of Railway Economics in Washington, all



Curves Showing Average Life of Locomotives

the data for which is in the files of the Bureau of Valuation of the Interstate Commerce Commission.

In the tabulation the first column shows the age of the locomotive. The second column gives the total years of expected life, which will be seen to gradually increase. The third column gives the future life expectation. That is the number of years that a locomotive may still be expected to remain in service at any given age and is the difference between columns two and one.

The table is graphically illustrated by the diagram, from which the trend of life can be readily seen. At the start there is no increase of life for six years, then there is a slow rise gradually increasing in rate up to an age of 31 years and then falling off at a gradually increasing rate to the end.

The curve showing the life remaining to a locomotive at any period of its existence falls off at the rate of one year for each year of its life for six years. This rate drops to 11 year per year at the age of 31 and then increases to 59 at the end.

By the use of a plainmeter on the upper curve of this diagram and obtaining therefrom its average height, we find that the average life of these 8,165 locomotives was 34½ years.

This is the first careful and reliable study on this subject that has ever been made. Frequently there comes to light a record of great longevity on the part of some locomotive, but a half century of service is always regarded as a great age. The placing of the average life at 34½ years, strikes very close to, though possibly slightly above what most railroad men would have guessed. And it is of interest and value to have this definite information on the subject.

MORTALITY TABLE OF STEAM LOCOMOTIVES SHOWING THE EXPECTED TOTAL LIFE OF LOCOMOTIVES AT EACH YEAR OF AGE BASED ON AN ANALYSIS OF THE HISTORY OF 8,165 LOCOMOTIVES OF NINE WESTERN RAILROADS

	Expected Life			Expected Life	
Age in Years	Total Years	At Given Age	Age in Years	Total Years	At Given Age
0	29.857	29.857	23	32.26	9.26
1	29.86	28.86	24	32.64	8.64
2	29.86	27.86	25	33.07	8.07
3	29.86	26.86	26	33.57	7.57
4	29.86	25.86	27	34.14	7.14
5	29.86	24.86	28	34.83	6.83
6	29.86	23.86	29	35.58	6.58
7	29.87	22.87	30	36.40	6.40
8	29.88	21.88	31	37.29	6.29
9	29.89	20.89	32	38.18	6.18
10	29.90	19.90	33	39.05	6.05
11	29.92	18.92	34	39.88	5.88
12	29.96	17.96	35	40.67	5.67
13	30.02	17.02	36	41.39	5.39
14	30.10	16.10	37	42.01	5.01
15	30.23	15.23	38	42.55	4.55
16	30.38	14.38	39	43.01	4.01
17	30.56	13.56	40	43.39	3.39
18	30.78	12.78	41	43.70	2.70
19	31.02	12.02	42	43.94	1.94
20	31.29	11.29	43	44.09	1.09
21	31.59	10.59	44	44.50	.50
22	31.91	9.91			

Test of the Automatic Straight Air Brake on the Norfolk & Western Railway

By the Bureau of Safety, Interstate Commerce Commission

As announced in the June issue of this paper, the Bureau of Safety of the Interstate Commerce Commission will conduct a special test of the automatic straight air brake on the Norfolk & Western Railway in order to clear up certain questions that were raised as to the functioning of the brake at the recent hearing on power brakes in Washington.

The tests will be under the immediate supervision of Director W. P. Borland and Assistant Director W. J. Patterson, of the Bureau of Safety,* and they are scheduled to start as soon as final arrangements can be made.

They will be very elaborate and cover a wide range of operation and they are expected to occupy about 30 days. For the conduct of the work there will be a force of 23 men from the Bureau of Safety employed.

Tests will be made with trains of 50, 75 and 100 cars. As the work will be under the exclusive control of the Bureau of Safety, no persons other than assigned employes and designated observers will be allowed in the locomotive cab during the tests, and those permitted to remain in the dynamometer car will be quite limited.

Among the rules for conducting the tests, it is set forth that in each running test observers will make note of the shock which occurs, if any, stating whether slight, heavy or excessive, and whether it occurred before or after brake applied, or before or after release; and, when the running tests are made on grades, whenever the train stops for a sufficient period of time, the observers are to note the thermal condition of the wheels. Each standing test will be made twice except those for the determination of the effect of brake cylinder leakage upon the operation of the automatic straight air brake equipment. A brake pipe leakage test will be made at the beginning of each day's work and after each change in the makeup of the train. During each series of running tests, the draft gear and couplers will be inspected and the train slack measured. All A. S. A. triple valves will be operated in quick release unless otherwise specified.

In both running and standing tests, the dynamometer car will be located next to the engine. The dynamometer car will be equipped with an A. S. A. brake. In running tests, and in standing tests so far as applicable, the chronograph on the car will be employed to register the following items: time, distance, location, speed, draw bar pull, integration draw bar pull line, draw bar pull buff, brake pipe pressure, emergency reservoir pressure, brake cylinder pressure, position of engineer's brake valve whether in service, lap, emergency or release.

By contact gauges the development of brake cylinder pressure of 10 lbs. at four locations in the train on the first and last cars and at two uniformly spaced intermediate points. The strokes of right and left air pumps will also be counted.

The purpose of the tests is to demonstrate the following points:

A. Control of loaded train by means of A. S. A. brake equipment.

B. Control of empty train by means of A. S. A. and Westinghouse brake equipment mixed.

C. Control of empty train by means of A. S. A. brake equipment.

D. Effect upon operation of A. S. A. triple valve of long and short piston travel in different parts of same train.

E. Minimum brake application that can be made with A. S. A. brake equipment with long piston travel.

F. Minimum brake application that can be made with A. S. A. brake equipment with short piston travel.

G. Minimum brake application that can be made with A. S. A. brake equipment with standard piston travel.

H. Effect of brake cylinder leakage upon operation of A. S. A. brake equipment.

I. Control of loaded train by means of A. S. A. and Westinghouse brake equipment mixed.

The first part will consist of a running test of a loaded A. S. A. train from Bluefield to Norfolk, 353 miles. The train will consist of 50 cars and will be operated in accordance with the rules of the Norfolk & Western Railway. On grades the speed of the train will be kept as nearly uniform as possible and all triple valves will be operated in graduated release on Bluefield and Allegheny grades, and 15 triple valves on the head end of the train will be operated in graduated release on Blue Ridge grade.

There are three main descending grades between Bluefield and the sea. At the start out of Bluefield there is a descending grade for 23 miles, averaging about .86 per cent, and ranging from short stretches of level to about 1.16 per cent. This is followed by a long run up the New River and a climb to the summit of the Allegheny Mountains, the eastern slope of which is about 12 miles long with an average gradient of about 1.23 per cent. East of Roanoke the road climbs to the summit of the Blue Ridge mountains, the eastern sloping grade of which is about 4½ miles long and has an average slope of 1.6 per cent.

In this test trainographs and duplex gauges will be located on the first car and at five-car intervals throughout the train. The contact gauges to register pre-determined pressure in the brake cylinders will be installed on the first, 17th, 34th and 50th cars. On the train assembled for this run, the brakes will receive only the ordinary maintenance in conformity with Norfolk & Western Railway practices. On the run emergency applications will be made at suitable points, and notes will be made as to whether any undesirable releases of the brake occur.

After the arrival at Norfolk a running test will be made with a train of 100 empty cars to Creive, 129 miles. This will constitute Series B of the schedule. In this train the first 37 to be equipped with A. S. A. triple valves, the next 25 to be equipped with Westinghouse triple valves, and the last 38 to be equipped with A. S. A. triple valves; running brake tests to be made at suitable locations en route, noting whether the shocks which occur, if any, are unusual or excessive, and whether the operation of either type or triple valve has any effect, either adverse or beneficial, upon the other type of triple valve.

Leaving Norfolk piston travel on first 18 cars and last 18 cars to be adjusted to 9 inches or more and on the remainder of A. S. A. cars from 4 to 6 inches, on Westinghouse cars, piston travel to be normal. On this run stops will be made from 10, 15 and 20 miles an hour by making 5, 10 and 15 lbs. reductions and then placing the engineer's valve in lap position in each case until the train stops.

After this has been done the train will be switched or the piston travel adjusted so as to have piston travel of 4 to 6 inches on first 18 cars and last 18 cars, and 9 inches or more on remainder of A. S. A. cars. On Westinghouse cars, piston travel to be normal. The above outlined tests will then be repeated.

The running tests of Series C will be made from Creive to Roanoke, 128 miles, with an empty train of 75 cars all equipped with the A. S. A. brake. On this run, brake tests will be made at suitable locations, and notes will be made as to whether the shocks which occur, if any, are unusual or excessive. The piston travel on first 19 cars and last 19 cars to be 9 inches or more, and on the remaining 37 cars 4 to 6 inches. Brake applications and stops will be made as before from 10, 15 and 20 miles an hour, and in addition thereto, an emergency stop will be made from 15 miles an hour and another from 7 miles an hour. After this last test the train will be switched and the piston travel will be adjusted so as to have piston travel 4 to 6 inches on the first 17 cars and the last 21 cars, and 9 inches or more on the intermediate 37 cars.

The above schedule of tests will then be repeated.

On arrival at Roanoke the Series D of the standing tests will be made. In these tests the piston travel on the first 17 and last 21 cars is to be from 4 to 6 in. and 9 in. or more on the remainder of the cars.

Reductions of 5, 10 and 15 lbs. will then be made and after each reduction the brake valve will be placed on lap and left in that position until the conclusion of the test. A note will be made of the brake cylinder and brakepipe pressure on each car that is equipped with gauges each minute for 3 minutes after the brake starts to apply.

The train will then be switched so as to have the piston travel on the first 18 and last 19 cars, 9 inches and from 4 in. to 6 in. on the remaining cars of the train. The above outlined test will then be repeated.

In the Series E tests, the piston travel will be made 9 in. or more on each car. First there will be a 3 lb. reduction, and the brake valve placed in lap position where it will be left until the conclusion of the test, and the same memoranda made as in the case of the D Series tests. Then the test will be repeated with a 5 lb. and 8 lb. reduction successively.

In the case of the F Series, the piston travel will be adjusted on each car so that it will be between 4 in. and 6 in. and the tests of Series D repeated.

In the Series G tests the piston travel will be so adjusted as to lie between 6 in. and 8 in. on each car, and the tests of Series D repeated.

In the Series H tests the normal piston travel of from 6 in. to 8 in. will be used on each car. First the brake cylinder leakage on each car will be noted and it will be adjusted to approximately 10 lbs. per minute from a pressure of 50 pounds.

First there is to be an 8 lb. reduction and the brake valve placed in lap position. The brake cylinder and brakepipe pressures will be taken on each car equipped with gauges for 5 minutes after the brake starts to apply. The brake will then be released and a note made of the time required to release and recharge to the initial pressure.

Then with a 20 lb. reduction the brake valve will be put on lap and held for one minute after brakepipe exhaust ceases. Then release and recharge as before.

These two tests will then be repeated with all of the triple valves in graduated release.

Then the brakes will be adjusted to operate in quick release, when an emergency application will be made, leaving the brake valve in emergency position, and note whether any brakes release in a period of 5 minutes. Brake cylinder leakage on each car is then to be adjusted to approximately 17 lbs. per minute from 50 lbs., and the above tests repeated.

The same is to be done with the brake cylinder leakage on car 49 to be created equivalent to amount of air which can be supplied by the triple valve. Brake cylinder leakage on all other cars to be normal. This last condition is to be created first on cars 39 and 49, and then on cars 29, 39 and 49, with the leakage on the other cars normal and the tests repeated. Finally this same amount of leakage is to be created on car 2, that on all other cars remaining normal, and the tests repeated.

The work will then go back to Series B and a running test will be made with a train of 75 empty cars from Bluefield to Roanoke, 106 miles, in order to demonstrate the control of trains of empty cars having Westinghouse and A. S. A. equipment mixed. In this train the first 25 cars next to the engine will be equipped with Westinghouse triple valves, the next 25 cars will have the A. S. A. triple valves, and the last 25 cars will have Westinghouse valves. Running brake tests will be made at suitable locations en route, noting whether the shocks which occur, if any, are unusual or excessive and whether the operation of either type of triple valve has any effect, either adverse or beneficial, upon the operation of the other type of triple valve.

The piston travel will be adjusted to 6 in. to 8 in. in accordance with the practice of the Norfolk & Western Railway Company.

On this run the tests outlined for the empty car train in the other Series B tests between Norfolk and Creive, will be repeated.

A final test of Series I will be made with a loaded train of 50 cars, from Bluefield to Roanoke to demonstrate the control of a loaded train having Westinghouse and A. S. A. equipment mixed. The train will be made up as follows: 10 cars equipped with Westinghouse triple valves, 10 cars equipped with A. S. A. triple valves, 10 cars equipped with Westinghouse triple valves, 10 cars equipped with A. S. A. triple valves, 5 cars equipped with Westinghouse triple valves and 5 cars equipped with A. S. A. triple valves; all retainers on Westinghouse cars to be turned up, and all A. S. A. triple valves to be operated in graduated release.

This train will be run and operated in accordance with the rules of the Norfolk & Western Railway Company.

Trainographs and duplex gauges will be located on the first car and at five-car intervals throughout the train. The contact gauges to register predetermined pressure in the brake cylinders will be installed on the first, 17th, 34th and 50th cars.

The control of the train will be observed and when an opportunity offers thermal tests will be made of the wheels, especially at Elliston, which is at the foot of the Allegheny grade. Notes will be made as to whether stops are properly made at desired points; whether the shocks which occur, if any, as a result of brake operation, are unusual or excessive, and whether the operation of either type of triple valve has any effect, adverse or beneficial, upon the operation of the other type of triple valve. Emergency applications will be made at suitable points and notes made as to whether any undesired release of brakes occurs following emergency applications.

On account of the variety of conditions met in the handling of trains down grades on different divisions, it is the practice to give personal instructions to the train crews as to the best methods for handling the trains in these respective districts. The instructions are given by the supervisory forces of the air brake department and by the road foreman of engines and their assistants.

The methods of brake manipulation vary in the different districts in conformity with the kind of equipment, and length and tonnage of trains handled. The instructions given by the road foreman on different divisions in regard to the manipulation of air brakes are briefly described as follows:

On the Norfolk Division between Norfolk and Roanoke the brakepipe pressure is 70 lbs.; main reservoir pressure 120 lbs. On descending grades where brake power is an important factor in the operation of train, a sufficient reduction is made in the application of the automatic train brake to slow the train down to the desired speed. The independent brake is then released on the locomotive and the automatic brake is left applied on the train. When necessary to release the brakes on the train, the independent locomotive brake is re-applied until the train brake is released, after which the independent brake is released on the locomotive. This manipulation is repeated as often as may be necessary to maintain the desired speed.

On the Radford Division between Roanoke and Bristol the brakepipe pressure is 70 lbs. except eastbound Bluefield to Roanoke, where the pressure is increased to 80 lbs.; main reservoir pressure 120 lbs. In making brake applications, the slack is bunched in the train by applying the independent brakes on the locomotive before applying the train brake. When releasing, the operation is reversed to avoid slack action. Through dips, such as exist on the Bluefield grade, the enginemen are instructed to apply the brakes far enough in advance of reaching the dip so the brakes will be released sufficiently on the train for it to drift through the dip without brake action. In passing out of the dip, the independent brake is used to prevent the locomotive from running away from the train, thus preventing excess slack action. Where conditions will permit, enginemen are instructed to make light applications of the brakes and maintain the speed as nearly uniform as possible. On broken grades between Elliston, Virginia, and Roanoke, Virginia, the instructions are to use the train brake as little as possible, and where the brake is applied, the speed of the train should not be reduced below 18 or 20 miles an hour before releasing. In releasing the train brake, the independent brake is held on the locomotive to prevent the slack from running out.

In the westbound 90-car empty trains, the engine crews are instructed to use the train brake as little as possible. It is only necessary to use the train brake between Christiansburg, Virginia, and Walton, Virginia; in releasing, the independent brake is held on the locomotive to keep the slack bunched until the train brakes are fully released.

Maximum speed restriction for trains of this type on Bluefield, Allegheny and Blue Ridge grades, 20 miles per hour.

The Fastest Train in the World

The fastest regularly scheduled train in the world, as far as is known, will be placed in service on the Great Western Railway (England) on July 9, when that company inaugurates its summer passenger schedules. The new train will operate between Cheltenham and Paddington station, London, and its high speed will be made between Swindon and Paddington, a distance of 77½ miles, which the train is scheduled to negotiate in 75 minutes—a speed of 61.8 miles per hour. There are many regularly scheduled express trains in England, however, which travel at speeds approximating this. In this country high rates of speed comparable to those in England can be found only in the Camden-Atlantic City services of the Pennsylvania and the Philadelphia & Reading.

Withdrawal of the Pennsylvania Hand Brake Suit

A notice was published in the March, 1923 issue of this paper that the Pennsylvania Railroad had instituted a suit against the several members of the Interstate Commerce Commission asking that an order be issued restraining them from the enforcement of the law regarding the use of hand brakes on grades.

It is known that the law prohibits the use of hand brakes for the control of trains on grades and the object of the suit was to secure an annulment of this prohibition.

The suit was brought in the district court of the United States for the middle district of Pennsylvania, Pennsylvania Railroad Company complainant.

The petition for withdrawal reads:

And now, this 7th day of May, 1923, the defendant by its counsel respectfully requests to withdraw the bill in equity filed in this case, and that the same be dismissed without prejudice. Spencer G. Nauman, J. E. B. Cunningham, C. H. Bergner, Attorneys for Plaintiff.

And now, May 7th, 1923, it is hereby ordered and decreed that the bill be dismissed in accordance with the above petition. Charles B. Witmer, District Judge.

An explanation is needed of the terms used in this petition. It will be noticed that the petition is made by the defendant and signed by the plaintiff's attorneys. The reason is that the Interstate Commerce Commission had sued the Pennsylvania R. R. for violation of the law regarding the use of hand brakes, making the company the defendant. As such it filed a bill in equity to restrain the commission from the prosecution of the suit and hence it was filed as the defendant.

The Qualifications of a General Manager

Probably in no profession is there demanded a more diverse knowledge of the activities of the world than that which must be possessed by the railroad manager. As a chief executive, he must be so thoroughly informed that he can prophesy to a nicety far ahead, and be prepared to meet every possible emergency in trade or financial conditions. As a traffic manager, he must canvass the markets of the world, and be able to decide at a moment's notice how the transportation of his road can be disposed of to the best advantage, and with due respect to its obligations to the public. As a manager, he must be well trained in not only the technical operation of his road, but he must, as well, familiarize himself with the changes in methods and facilities that are taking place in the industries within his territory, and must know what influences such changes will have upon the character and volume of the output; and last but not least, he must be in touch with and have critical knowledge of labor econditions in every department of the service, and a general knowledge of such conditions elsewhere.—Theo. N. Ely.

The Transportation Program for 1923

A statement has been issued by the American Railway Association to the effect that for the period of 37 weeks ending March 17, 1923, the railroads handled the greatest volume of traffic ever handled during a corresponding period, and that in spite of the miners' and shopmen's strike this amounted to 32,939,789 revenue cars loaded or 1,270,933 more than for the previous high record in 1919. Anticipating a still larger development in agriculture and other departments of industry, individual railroads purchased 223,616 new freight cars, 4,219 locomotives in the 14 months commencing January 1, 1922.

The significance and importance of these figures will be appreciated when it is remembered that the average number of new cars and new locomotives added over a period of ten years, 1913 to 1922 inclusive, has been 101,009 new cars per year, 1,960 new locomotives per year, and that during the two years and two months of Federal control there were purchased a total of 100,000 new cars or approximately 46,000 per year, 1,930 new locomotives or approximately 890 per year.

Aggregate carrying capacity of freight cars increased in the ten year period, 1912 to 1921 inclusive, 22.9 per cent; and aggregate tractive power locomotives increased during same period 40.8 per cent.

The railroads have authorized expenditures for equipment and other facilities of approximately $1,100,000,000 for the year 1923 of which $675,000,000 is for cars and locomotives

An attempt will be made to reduce cars awaiting repairs to a normal basis of five per cent of the total equipment, and locomotives to 15 per cent when the peak movement begins on October 1.

It is recommended that the railroads complete their coal storage requirements by September 1; that the use of power and equipment for railroad construction and maintenance purposes be restricted to a minimum after September 1, so as to leave the facilities available for commercial purposes; that a campaign be inaugurated to move the largest possible tonnage by the lakes; that road and building construction be prosecuted as early in the season as possible; that all interested be impressed with the necessity of loading all cars to a maximum capacity and to raise the average loading to 30 tons for the entire country; that every possible means be adopted to increase the mileage per car per day to an average of 30 for the entire country, and finally that it be urged that it is only by the co-operation of the shipping public that these ends can be attained.

It was further suggested that individual roads give to the general public and to the patrons of their respective lines information as to their program, and also keep them currently advised of the progress made hereunder, including, so far as the individual line is concerned, information as to the progress made in its locomotive and car repairs and other improvements in transportation facilities.

Notes on Domestic Railroads

Locomotives

The Ferrocarril De Antioquia, Columbia, has ordered 2 Consolidation type locomotives from the American Locomotive Company.

Central Est Palma has ordered one locomotive from the American Locomotive Company.

The Washington Run R. R. has ordered one locomotive from the American Locomotive Company.

Champion Fibre Company has ordered one locomotive from the Lima Locomotive Works.

The Meridian Lumber Company, Meridian, La., has ordered one Consolidation type locomotive from the Baldwin Locomotive Works.

The Union Terminal Company has ordered one switching locomotive from the Baldwin Locomotive Works.

The Argentine republic has ordered one locomotive from the Baldwin Locomotive Works.

The Red River & Gulf R. R. has ordered one locomotive from the Baldwin Locomotive Works.

The Sewell Valley R. R. Co. is inquiring for one Mikado type locomotive.

The Atlantic Fruit Company of Central Tanamo, Cuba, has ordered 2 Consolidation type locomotives from the Baldwin Locomotive Works.

The Norfolk & Western Ry. Co. is inquiring for 10 locomotive tenders.

The Gulf, Mobile & Northern R. R. Co. has ordered 5 Decapod type locomotives from the Baldwin Locomotive Works.

The Arica-La Paz has ordered one rack-engine from the Baldwin Locomotive Works.

The Union Railroad Co., has ordered 10 heavy 6-wheel switching locomotives from the Lima Locomotive Works.

The Donovan Crockery Company has ordered one Mikado type locomotive from the Baldwin Locomotive Works.

Rede Sul Minera, Brazil, has ordered 2 Consolidation type locomotives from the Baldwin Locomotive Works.

The Canadian National Rys. have placed an order with the Montreal Locomotive Co. for 35 Mikado type locomotives specially designed for use in Western Canada.

The Virginian Railway Co. has ordered 36 electric motive power units from American Locomotive Company and the Westinghouse Electric & Manufacturing Company.

Rede Sul Minera, Brazil, has ordered 2 Consolidation type locomotives from the Baldwin Locomotive Works.

Freight Cars

The New York, New Haven & Hartford R. R. is inquiring for repairs to 1,000 steel underframe box cars.

The Western Maryland Railway will repair 2,000 steel underframe box cars at its own shops in Baltimore, Md.

The Central R. R. of New Jersey is inquiring for repairs to 300 hopper cars.

The Pennsylvania R. R. has ordered 10 steel car floats from the New York Shipbuilding Corp.

Cosden & Company, New York, are inquiring for 2 tank cars of 10,000 gal. capacity and 3 of 8,000 gal. capacity.

The Union Railroad is inquiring for 50 flat car bodies of 70 tons' capacity.

The Canadian National is inquiring for prices on the repairs of 2,500 box cars.

The Muscle Shoals Birmingham & Pensacola Ry Co. is inquiring for 50 box cars of 40 tons capacity and 50 flat cars of 40 tons capacity also for 50 gondola cars, low side, of 50 tons capacity and 50 steel hopper cars of 50 tons capacity.

The Anaconda Copper Mining Company, New York, is inquiring for 24 dump cars, 2 ballast cars, and 6 flat cars.

The Canadian National Rys. is inquiring for 100 automobile cars of 40 tons capacity and for 1,000 box cars of 40 tons capacity, also 1,000 box cars of 60 tons capacity.

The Virginian Railway has ordered 25, 120 tons gondola cars from the Pressed Steel Car Company.

The Detroit United Railway is inquiring for 25 flat cars.

The Nashville, Chattanooga & St. Louis Ry. is inquiring for 75 hopper bottom cars of 55 tons capacity and 175 drop bottom gondola cars of 70 tons capacity.

The Sinclair Refining Company, Chicago, Ill., is inquiring for 18 coke cars.

The Northwestern Railway of Brazil is inquiring through the car builders for 50 steel frame stock cars of 24 tons capacity.

The New York Central is inquiring for 750 bolsters for repair work on cars.

The Birmingham Southern R. R. Co. is inquiring for 50 composite coal cars of 70 tons capacity.

The Argentine State Railways are inquiring for one air brake instruction car.

The Shell Company of San Francisco has ordered 60 tank cars of 10,000 gal. capacity with 50 tons trucks from Pennsylvania Tank Car Company.

The Missouri Pacific R. R. is inquiring for repairs to 350 freight cars.

The Atlantic Coast Line R. R. is inquiring for 50 steel underframes.

The Gulf Smokeless Coal Co. is inquiring for 75 mine cars.

The Chicago, Milwaukee & St. Paul Ry. is inquiring for 500 steel underframes. This road is also in the market for repairs to 300 freight cars.

The Southern Pacific Co. is reported to be inquiring for 50 gondola cars.

The New York Central R. R. is reported to be inquiring for repairs to 2000 freight cars.

The Phelps-Dodge Co. has placed an order with the Mt. Vernon Car Manufacturing Co. for 66 hopper cars.

The Utah Copper Co. has placed an order with Magor Car Corp. for 6 cabooses and 4 work cars.

Passenger Cars

The Missouri Pacific R. R. Co. is inquiring for 5 coaches and 10 baggage cars.

The American Short Line Railroad Association Consolidated Purchasing Agency is in the market for three General Electric gas-electric cars.

The Chicago & Eastern Illinois has placed an order for two dining cars with the Pullman Company.

The Pacific Electric Railway is reported to be inquiring for 50 motor coaches.

The Atlantic Coast Line R. R. is reported to have placed an order with the Osgood Bradley Car Co. for 25 Combination baggage and mail cars.

The Southern Pacific Co. has ordered 50-52 ft. center entrance street cars from the St. Louis Car Co. for the Pacific Electric Ry.

The Wabash Ry. is inquiring for one private car.

Buildings and Structures

Western Pacific R. R. Co. will construct additions to its car and locomotive shops at Sacramento, Calif., at a cost of approximately $225,000.

St. Louis-San Francisco Ry. will construct a new shop building at St. Louis, Mo. This will include a 20-stall roundhouse, machine shop, car plant and two wash-rooms and will cost approximately $500,000.

Chicago, Rock Island & Pacific Ry. Co., contemplates the construction of an addition to its engine house and shop at Caldwell, Kan., to cost approximately $40,000.

Denver & Rio Grande Western R. R. Co., will construct a new engine house at Green River, Utah.

Michigan Central R. R. is reported to be taking bids on a general contract for extensions and improvements in its engine house and repair shop at Detroit, Mich.

St. Louis-San Francisco Ry. will construct a shop building at East Thomas, Ala. The contract has been awarded to John M. Olsen, of Springfield, Mo.

Lehigh Valley R. R. is reported to be considering the removal of its locomotive repair shops from Delano, Pa. to Hazelton, Pa. The shops at Ashmpre will be extended to handle repair work for the Hazleton and Mahanoy division.

Mobile & Ohio R. R. have started work on the new 26 stall roundhouse at Jackson, Tenn.

Detroit United Ry. has plans under way for rebuilding its car shops recently destroyed by fire.

Illinois Central R. R. have awarded a contract to J. E. Nelson & Sons of Chicago for the construction of an engine house at Central City, Ky.

The Atchison, Topeka & Santa Fe Ry. is reported to have plans under way for the construction of a machine, tin and pipe shop at San Bernardino, Calif., to cost approximately $500,000. This road will soon take bids for the construction of a one-story concrete machine shop at Guthrie, Okla.

Denver & Rio Grande Western R. R. Co. has awarded a contract to Battey & Kipp, Chicago, for construction of addition to the shops and enginehouses at Denver, Colo., and Salt Lake City, Utah.

Texas & Pacific Ry. Co., plans the construction of a new roundhouse and engine terminal at Dallas, Texas.

The Missouri Pacific R. R. is reported to have awarded a contract to H. W. Underhill & Co. of Wichita, Kan. for the construction of a new one-story & basement engine house and repair shop at Wichita, Kan.

Louisville & Nashville plans the construction of a one-story machine shop at Etowah, Tenn., to cost approximately $30,000.

Michigan Central has awarded a contract to Ellington Muller Co., Chicago, for the construction of an extension to its roundhouse at West Detroit, Mich., to cost approximately $80,000.

The Chicago & Eastern Illinois Ry. has purchased a 110-acre tract of land between Terre Haute and North Terre Haute, Ind., to be used as the site for its new locomotive and car shops. Plans are now under way for the first building.

The Chesapeake & Ohio Ry. will make improvements and extensions in its engine terminal at Taplin, W. Va., to include the installation of a cinder conveyor system, 100 ft. turntable, and a pumping and water station for locomotive service.

The Union Pacific Railroad has contracted with Graver Corporation, East Chicago, Ind., for two Type "K" Softeners of 25,000 Gal. per hour capacity at Armstrong, Kans. and at Marysville, Kans.

The Chicago, Burlington & Quincy Railroad has contracted with Graver Corporation, at East Chicago, Ind., for the erection of the following Type "K" Graver Water Softeners:

Capacity	Location
46,000 Gal. Per Hr.	Burlington, Ia.
27,000 Gal. Per Hr.	Ottumwa, Ia.
10,000 Gal. Per Hr.	Louisville, Nebr.
29,000 Gal. Per Hr.	Alliance, Nebr.

Supply Trade Notes

Wm. A. Bradshaw has joined the **Franklin Railway Supply Company, Inc.**, New York, as Inspector. Mr. Bradshaw was for several years in the motive power department of the New Jersey Central R. R., engaged on locomotive repairs, erections, and breaking in overhauled locomotives. Previous to that he was a fireman in freight and passenger service. Mr. Bradshaw also spent several years as shop foreman, handling production, with the Marconi Company of America. From the Marconi Company he went to the engineering department of the American Can Company working between the chief engineer and the shop, and later becoming connected with the mechanical end of the automotive industry.

General American Tank Car Corp., and the **General American Car Co.**, announce the appointment of **Henry Donovan**, formerly of Union Pacific System, as general manager of all manufacturing departments, effective July 1, 1923.

The Boyden Steel Corporation has removed its offices from the Keyser building to larger quarters in the Standard Oil building, Franklin street and St. Paul Pl., Baltimore, Md.

F. H. McGuigan, Jr., engineer for the Northwestern, Central Western and Southwestern regions of the United States Railroad Administration with headquarters at Chicago, has resigned to become assistant to the president of the **Railway Car Manufacturers Association**, New York City.

The Electric Steel Company, Chicago, Ill., has been changed to the **Nugent Steel Casting Company.** There is no change in management, ownership or personnel.

William A. Frye is now service engineer with the **Franklin Railway Supply Co., Inc.**, New York. Mr. Frye served his apprenticeship as a machinist on the Atchison, Topeka and Santa Fe Railroad, beginning in 1900. From the Santa Fe he went to the Frisco Railroad at Springfield, Mo., as a toolmaker. After 18 months with this road, he went with the Missouri Pacific as a roundhouse foreman. He was subsequently promoted to division foreman at Council Grove, Kansas, and later to air foreman at Kansas City, Mo., the position he was filling at the time he resigned to join the Franklin Railway Supply Company.

C. D. Lentz has joined the **Franklin Railway Supply Company, Inc.**, New York, as inspector. Upon completing a four year machinist's apprentice course in the New York Central Railroad Shops at Avis, Pa., Mr. Lentz was appointed piece work inspector. Later he was made machine inspector of New York Central repair locomotives at the Baldwin Locomotive Works. On January 1, 1923, he was made chief inspector of this class of work, and continued in this position until June 1, 1923, when he resigned to join the Franklin Railway Supply Company, Inc.

S. H. Winslow has joined the **Franklin Railway Supply Company, Inc.**, New York as service engineer. Mr. Winslow was born at Feeding Hills, Mass., March 15, 1887. He attended the public schools of Kansas City, Mo., and East Orange, N. J., and is a graduate of the Alabama Polytechnic Institute, class of 1908. His first railroad employment was with the Baltimore and Ohio as a material inspector in 1913. From 1914 to 1915 he was in charge of road tests with dynamometer car on this road. Mr. Winslow resigned from the B. and O. to take charge of development work for the Chemical Products Company, Washington, D. C., in 1917; in 1918-19-20 and 21 he was mechanical engineer in charge of plant installation, United States Food Products Corporation, engineer in charge of plant design and erection, Colgate Food Products Corporation, 1922. During the summer and fall of 1922, Mr. Winslow was engaged in plant demolition and salvage for the city of Baltimore on the Gunpowder Falls Water Development.

The Roller-Smith Company, 233 Broadway, New York, N. Y., announces the appointment of **H. D. Baker**, 525 Woodward Ave., Detroit, Michigan as its representative in the State of

Michigan. Mr. Baker will handle the Roller-Smith Company's lines of instruments, circuit breakers and radio apparatus in that territory. Having been associated with the Roller-Smith Company in various capacities for a period of several years Mr. Baker is very well equipped to handle the Roller-Smith Company's lines as he knows these lines fully and has a wide acquaintance in his territory.

The National Safety Appliance Company, Chicago, has removed its offices from the Peoples Gas Building to 1527 Railway Exchange building.

G. R. Grove is now mechanical inspector with the **Franklin Railway Supply Company, Inc.,** New York. Mr. Grove is a graduate of the York, Pa., High School (1898). After a three year course in mechanical drawing at Drexel Institute, Philadelphia, he served an apprenticeship in locomotive construction and machinery at the Baldwin Locomotive Works. He spent six years as a foreman in the Baldwin plant and two and a half years as foreman and plant inspector at the Lima Locomotive Works, Inc. He was also with Hunt and Company as inspector of new locomotives.

Lawrence Wilcox, mechanical expert for the **Westinghouse Air Brake Company,** has been transferred to Columbus, Ohio, as a representative of this company and the Westinghouse Traction Brake Company.

S. T. Reid, formerly a locomotive engineer on the Michigan Central, has been appointed mechanical expert for the **Westinghouse Air Brake Company** with headquarters at Chicago, succeeding Mr. Wilcox.

Horace S. Clark has been made Pacific district manager of the **Westinghouse Air Brake Company,** to succeed C. P. Cass, who has resigned to devote more time to the Westinghouse Pacific Coast Brake Company of which he is president. Mr. Clark, who was assistant manager of the Pacific district, will continue to maintain headquarters in San Francisco. Before going to the coast, Mr. Cass had been located in St. Louis as Southwestern district manager and president of the Safety Car Devices Company. Mr. Clark and Mr. Cass have a wide acquaintance among railroad men throughout the country.

Alex D. Lawrence has joined the staff of the **Franklin Railway Supply Company** as service engineer. Mr. Lawrence's first railroad employment was with the New York Central and Hudson River Railroad in April, 1902, on the Hudson Division as a locomotive fireman. He fired for four years, resigning in April, 1906, to accept a position with the Franklin Automobile Manufacturing Company at Syracuse. After four months with the Franklin Company he returned to railroad work, going with the Boston and Albany Railroad as locomotive fireman on the Albany Division. After firing a year on this road Mr. Lawrence was promoted to engineer, running freight and passenger trains until he resigned to join the Franklin Railway Supply Company, Inc.

S. Bert Bennett has joined the **Franklin Railway Supply Company, Inc.,** as service engineer. Mr. Bennett spent 17 years with the Lehigh Valley Railroad as fireman, engineer, and assistant road foreman of locomotives, assigned to special work at various times by Mr. F. N. Hibbits, superintendent of motive power. Immediately prior to joining the Franklin Railway Supply Company on May 15, 1923, Mr. Bennett had charge of Lehigh Valley locomotives equipped with Boosters, Elvin and Duplex Stokers.

James C. Bennett, comptroller of the **Westinghouse Electric & Manufacturing Company** was elected a director of the Company at a meeting of the stockholders Wednesday, June 13, in the place of John R. McCune, who died May 14.

Mr. Bennett entered the employ of the Company almost immediately after graduation from high school in 1886 as assistant to the auditor. Inasmuch as the Company had been founded only five months prior to this time, he is one of its oldest employes. Mr. Bennett is also an officer and director of a number of the Westinghouse subsidiary companies.

Edwin F. Atkins of **E. Atkins & Company,** Boston, Mass., **Samuel M. Vauclain,** president of the **Baldwin Locomotive Works,** Philadelphia, Pa., and **E. M. Herr,** president of the **Westinghouse Electric & Manufacturing Company** were reelected on the Board of Directors at this meeting.

Items of Personal Interest

Samuel Lynn has been appointed master car builder of The Pittsburgh & Lake Erie R. R. Co., with headquarters at McKees Rock, Pa.

O. G. McPhail has been appointed master mechanic of Michigan Central with headquarters at Bay City, Michigan, succeeding J. O. Goodwin, deceased.

D. J. Redding has been appointed superintendent of motive power of the Pittsburgh & Lake Erie with headquarters at Pittsburgh, Pa. in charge of the motive power department.

C. C. Peters, formerly road foreman on the Chicago, Burlington & Quincy, with headquarters at Lincoln, Nebr., has been appointed fuel supervisor with headquarters at Chicago.

J. T. St. Clair has been appointed acting engineer of car construction of the Atchison, Topeka & Santa Fe, with headquarters at Chicago.

O. S. Jackson, formerly assistant superintendent of motive power and machinery of the Union Pacific System, with headquarters at Omaha, Nebr., has been appointed superintendent of motive power and machinery with the same headquarters.

Paul Hamilton has been appointed assistant chief engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., the Cincinnati Northern R. R. and Evansville, Indianapolis & Terre Haute Ry., with headquarters at Cincinnati, Ohio.

Carl R. Harding has been appointed consulting engineer of the Southern Pacific Co. to succeed John D. Isaacs, who has retired.

I. E. Sanders has been appointed master mechanic of the Louisiana Railway & Navigation Company of Texas, with headquarters at Greenville, Texas.

M. J. McGraw has been appointed master mechanic of the Seaboard Air Line with headquarters at Jacksonville, Fla.

Hadley Baldwin, assistant chief engineer of the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Cincinnati, Ohio, has been promoted to assistant to the general manager with the same headquarters.

Porter Allen, division engineer of the Lake Division of the Pennsylvania, with headquarters at Cleveland, Ohio, has been promoted to superintendent of the South Bend division, with headquarters at Logansport, Ind.

W. C. Borchert, district engineer of the Louisiana Railway & Navigation Company of Texas, has been promoted to chief engineer with headquarters at Greenville, Texas.

B. A. Porter has been appointed inspector of transportation of the Missouri Pacific R. R. and will have headquarters at St. Louis, Mo.

James Matheson has been appointed acting master mechanic of the Seattle division of the Northern Pacific Ry., with headquarters at Seattle, Wash.

Silas Zwight has been appointed acting general mechanical superintendent of the Northern Pacific Ry. with headquarters at St. Paul, Minn.

George V. McGlinch has been appointed division master mechanic of the Northern Division of Michigan Central R. R., at Bay City, Mich., succeeding Joseph O. Goodwin, deceased. Mr. McGlinch was formerly road foreman of engines at this point.

Obituary

Joseph O. Goodwin, master mechanic of the northern division of the Michigan Central R. R. with headquarters at Bay City, Mich., died June 3, at Cleveland, Ohio. Mr. Goodwin was born in 1871, and began service with the Michigan Central R. R. as a fireman in 1887. He was later promoted to engineer and was appointed road foreman of engines in 1914, which position he held until his appointment to division master mechanic of the northern division in 1919.

William E. Manning, vice president and general sales manager of the Youngstown Sheet & Tube Co., also president of the Continental Supply Company and the Youngstown Steel Products Company died on June 15 at Youngstown, Ohio. He was born at Youngstown, in 1870, and had been with the Youngstown Sheet and Tube Co. since 1901.

Willard T. Sears, research and experimental engineer of the Niles-Bement Pond Company, New York City, died recently at Montclair, New Jersey. Mr. Sears was inventor and developer of many machine tool devices. He had been connected with the above company for many years.

New Publications

Railroad Electrification and the Electric Locomotive, by Arthur J. Manson, manager of the Transportation Division, Westinghouse Electric & Manufacturing Co., Simmons-Boardman Publishing Co., New York. 332 pages, 5¾ in. by 8¾ in.

It may be stated at the outset that this book is intended for all railway men interested in the present and future development of electricity as a motive power. The book will be found exceedingly valuable to the railroad officer who is confronted with the question of whether or not to electrify, and who must post himself as to what is available and be able to make an intelligent choice for such available facilities.

The necessities of such an officer are well expressed by the author in his preface when he says: "The importance of electrification as a method for increasing the capacity of existing steam railway facilities and reducing the cost of train operation, makes it imperative that railway officers and operatng men should have some knowledge concerning the elementary theory, the design, construction, care and operation of electric locomotives, as well as their application, to all classes of railroad service."

The book opens with a chapter on the "Advantages of Electrification," in which the usual statements are made as to increase of capacity, flexibility of operation and the like, and then for a number of chapters he strikes at the electrical features involved from a technical standpoint.

These early fourteen chapters are devoted to this: They constitute a clearly expressed course in electricity, starting with simple definitions or perhaps explanations would be a better term, and taking the reader through the general electrical features of the locomotive, to its method of operation, energy losses and closing with that interesting subject of regenerative braking.

Then comes a careful analysis of the mechanical features, starting with the special arrangements needed to adapt the air brake to the needs of the electric locomotive.

In the chapters that follow there is a discussion in detail of the various parts that go to make up the electric locomotive, such as the pantograph, the third rail shoe, the control apparatus, gear ratios and the like. And last, and possibly as valuable as any of the rest, are two chapters devoted to the solution of an electrification problem. Here the author enters into a detailed discussion of the method that should be pursued in deciding upon a question of electrification. He takes up the subject step by step, with a minuteness that could well be followed by any man who had a decision on the subject to make. To the layman these chapters will be exceedingly edifying, as showing the wide range of the investigations that must be made, in order to intelligently direct the electrification of a railroad. It sets forth the well known fact that the amount of detail involved in any large undertaking is almost without limit.

He then tells us of the electrifications that are already established and gives, in tabular form, a mass of valuable information as to these installations both in this country and abroad.

The last four pages of the book are occupied by the index.

Throughout the book the reader is impressed by the familiarity of the author with his subject and the clearness with which his meaning is expressed.

From end to end the book shows every evidence of careful work, work that cannot fail to be appreciated by the readers for whom it is intended, and whom it will assist in reaching the conclusions and making the decisions that are required of them.

Industrial Heating Installations, published by Westinghouse Company. An eight page booklet, Special Publication No. 1667, containing a list of over 300 successful installations of Westinghouse industrial heating apparatus has been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The list, although containing only the more important installations and omitting, therefore, a great many of considerable interest, is impressive because it gives a definite idea of the extent to which electricity is being used for industrial heating purposes and shows that electricity is not simply the fuel of the future, as is often supposed.

A few of the industries making use of electric heat are manufacturers of abrasives, manufacturers of airplanes, brick plants, bakeries, furniture factories, foundries, hospitals, railway companies, restaurants and cafeterias, rubber mills, steel mills, textile machinery manufacturers, textile mills tool manufacturers, and wire mills.

Westinghouse Electrical Supply Catalogue. The Westinghouse Supply Catalogue generally regarded as an encyclopedia of things electrical is now being distributed. This issue for 1923-24 replaces and supersedes all catalogues issued heretofore on electrical supplies by the Company.

In appearance the new catalogue does not differ greatly from its predecessor. The former editions have proved so useful and satisfactory that no essential features were altered, the improvements being largely a matter of detail and refinement.

Appreciating the importance of accessibility to the specific information wanted, the utmost care was used to meet this requisite. The catalogue is indexed according to subjects and to sections, and also has a style number and a thumb index. In addition, a new feature—a classified index—has been added to the introductory section under the title "How this catalogue serves." Here is listed apparatus of particular interest to Central Stations, Electric Railways, Industrial Plants, Mines, Contractor-Dealers, and Architects.

The catalogue announces the opening of a new plant at Homewood, Pa., which will be devoted exclusively to the manufacture of repairs and renewal parts for Westinghouse apparatus in service but of design no longer strictly standard. A complete list of all Westinghouse Sales offices, Agent Jobbers Warehouses, Service Repair Shops is also given, together with several illustrations of new combination sales, service and warehouse buildings either recently built or now in course of construction.

In all, 1300 pages are devoted to descriptive matter, technical data, dimension drawings, specifications and prices. The material includes all new apparatus developed in the last two years. The street lighting section probably shows the greatest revisions and over 175 pages are devoted to this feature.

Close observation shows that the new issue presents a wider variety of apparatus than any catalogue heretofore issued by the Company. All sections have been completely revised and some rearranged, which greatly facilitates the ordering of equipment.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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New Box Cars of the Southern Pacific

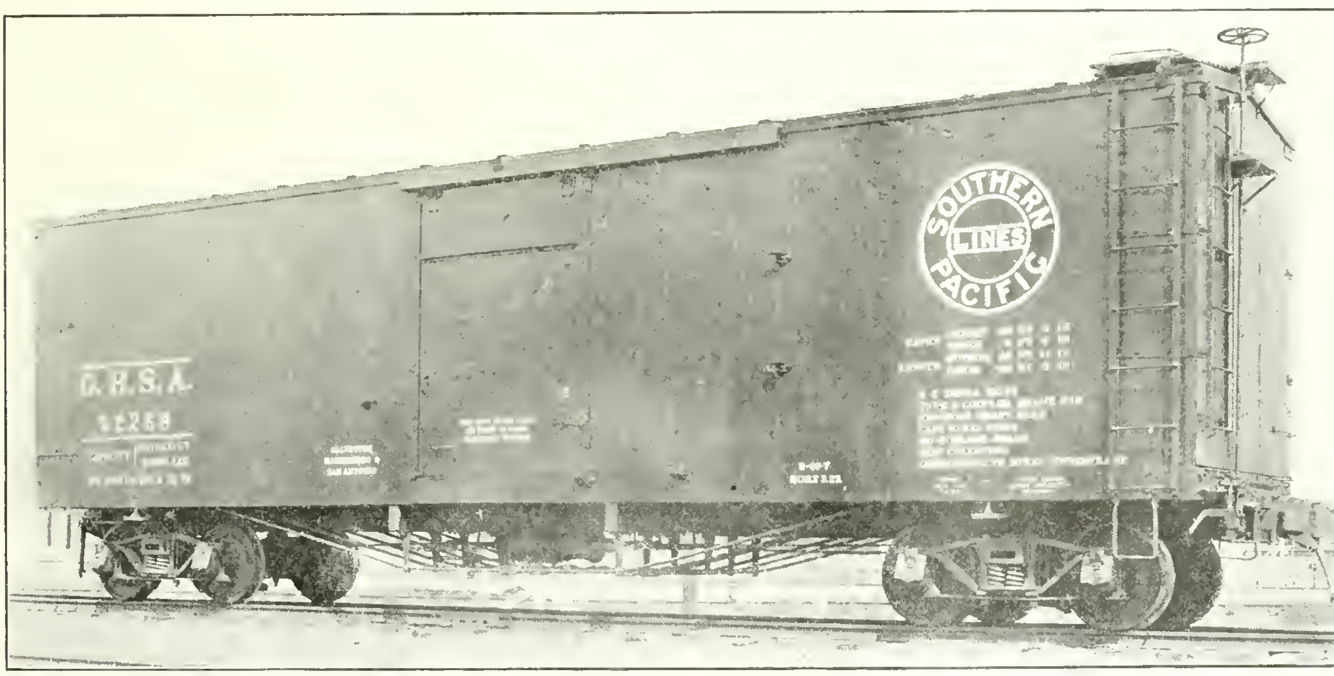
Something Artistic In Freight Car Design

By W. E. SYMONS

In speaking of railway equipment from an esthetic standpoint we invariably exclude freight cars of all kinds, for, "who ever seen or even heard of a beautiful freight car," as compared to a modern well appointed passenger coach, or a luxuriously furnished parlor, sleeping or private car, and although there has been in the past some beautiful engineering ideas embraced in freight car development they have not been applied in such manner as to appeal to the esthetic sense of the casual observer of the completed unit.

In the development of freight car equipment, following the advent of larger locomotives and increased tonnage per train, special attention has been given to strengthening the draft line or center sill construction which must in the last analysis be sufficiently strong to withstand all buffing and pulling shocks regardless of the feature of supporting the contents of the car, and to meet this condition the best talent of the railway engineers in America has diligently applied itself with wonderfully surprising results, although many inventions and plans have been tried that were not found satisfactory and had to be abandoned in favor of others of more proven merit.

In addition to the enlarged locomotive and increased tonnage per train the cars have also been built much heavier so that in the last few years few cars have been built of less than 80,000 pounds capacity, while a great majority of them are 100,000 pounds or 50 tons capacity.



New Box Car on the Galveston, Harrisburg & San Antonio Railroad of the Pacific Lines

Both the car manufacturer and the railway mechanical officers have constantly worked toward the end of reducing the number of parts in all kinds of railway equipment particularly cars and locomotives, and at the same time when possible using a material of greater strength, and in so far as possible reducing the weight of the completed unit. In freight car design in particular, this has in some cases resulted in trimming down certain integral parts to a point which did not leave sufficient strength in the completed unit resulting in failure to stand up under severe operating conditions when placed in service.

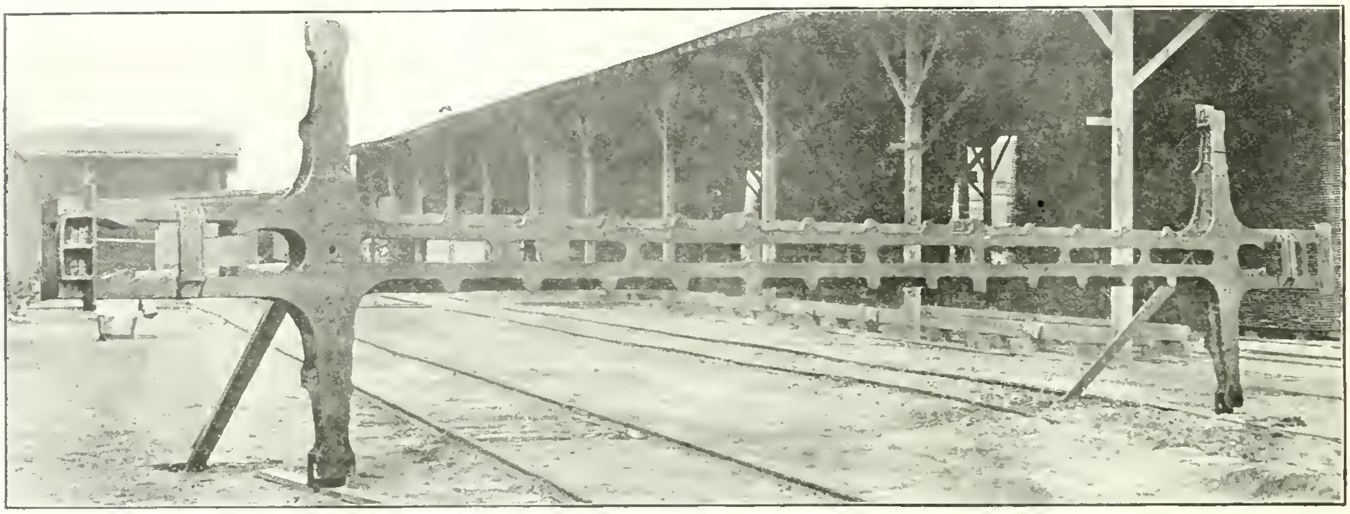
Some 30 years ago practically all freight car bodies were made entirely of wood with the exception of necessary bolts, rods, and a few castings used in their assembly, while locomotives were largely made up of boiler plates, wrought iron forging and grey iron or malleable iron castings, and on the first introduction or proposition to use steel castings in locomotive or car construction many of recognized authority indicated lack of faith in their suitability, and it is a regrettable fact that in their earlier use in locomotive construction, many of the parts, particularly driving wheel centers, were made entirely too light resulting in failure which was charged to the material, when it properly should have been charged to faulty design, as the material was far superior to cast iron.

Among the manufacturers of locomotive and car specialties, particularly of cast steel parts, the Commonwealth Steel Company of St. Louis, Mo., was a pioneer in the field, developed a great variety of designs, and has done much to reduce the number of parts, by making single castings take the place of several pieces.

Some 20 years ago a railway motive power officer conceived the idea of making a locomotive engine truck all in one steel casting, except possibly the outer truck frame jaws thereby reducing the number of parts from something over 40 to about 8 or 10 or a reduction of about 30 pieces or parts, and secured a patent on this design.

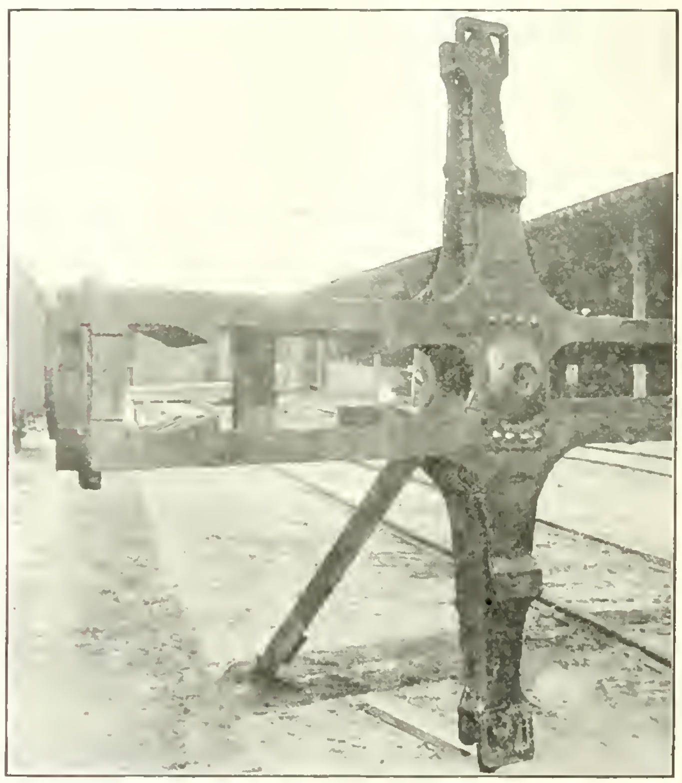
Some railway men who were consulted thought the move was entirely too bold, even to the point of rashness, and predicted its failure. When the design was shown to Mr. Clarence Howard, President, Commonwealth Steel Company, he not only said it could be made, but that he was then working on similar lines and at once purchased the patent, since then he not only developed this particular feature of locomotive design but has gone much farther in simplifying both passenger and freight car construction by displacing even a greater number of parts with one single casting.

The Southern Pacific Company has recently constructed in their own shops at Houston, Texas, ten modern freight cars in which is embodied a feature which is unique in car design and construction, a cast steel underframe or center section all in one piece. In other words the built up or fabricated frame as now commonly used in steel underframe cars which is made up of rolled plates, rivets, bolts, angles, brackets, etc., is in this case all poured from the moulder's ladle of molten steel in one piece. In this design the built up center sills with body bolsters would consist of about 800 pieces, which when poured from the moulder's ladle is reduced to *one* piece or 800 to 1.



One-Piece Cast Steel Underframe for Southern Pacific Box Car

Through the courtesy of Mr. J. A. Power, Superintendent of Motive Power and Equipment of the Southern Pacific Lines, we have been favored with a number of photographs, showing these cars both in finished state, and different views of the cast steel center sill section.



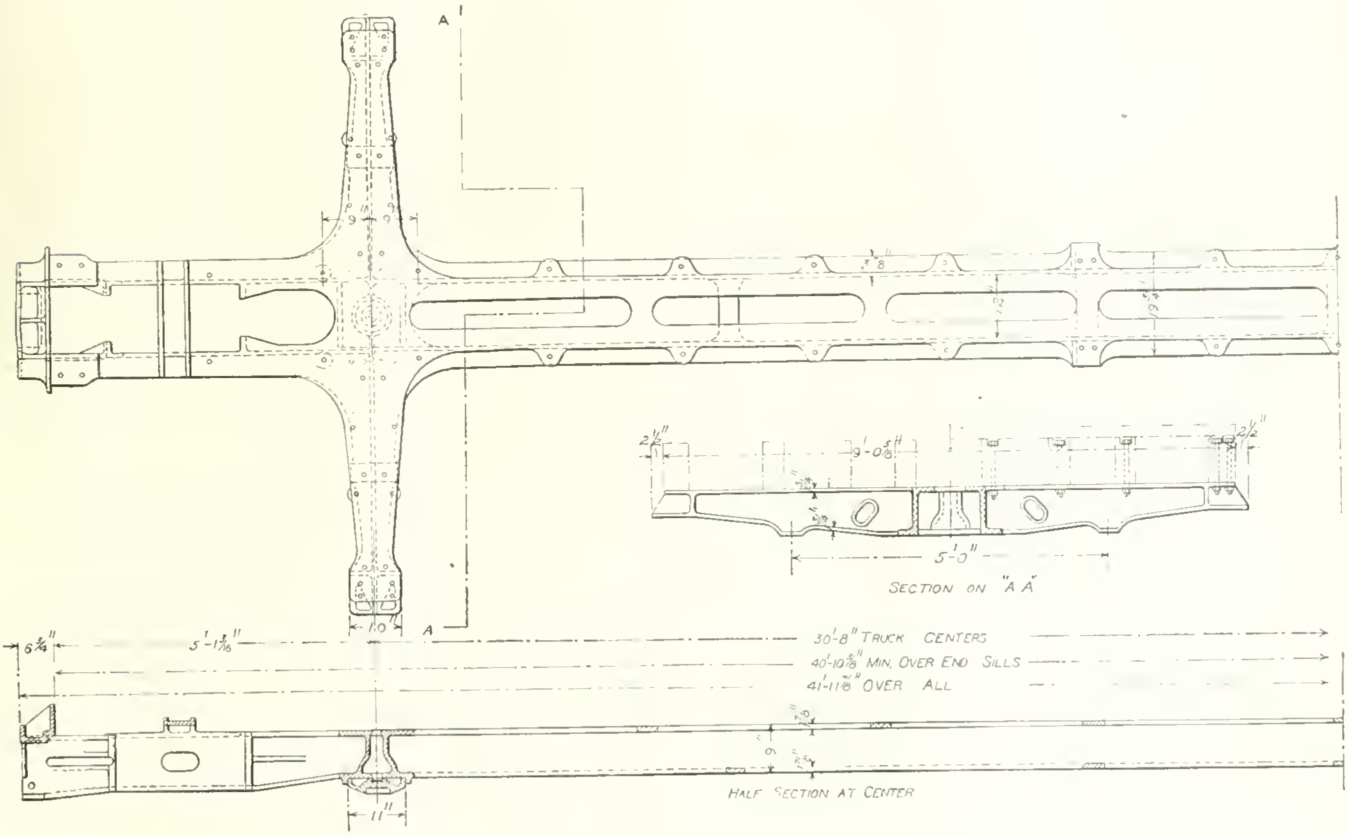
Bottom of One-Piece Cast Steel Underframe Showing Bolster and Center Plate

The interest in the car centers about this large center sill and bolster casting, and the method by which the body of the car is supported.

First as to the casting itself. It has a length of 41 ft. 11⅞ in. over all. It consists essentially of two Z-shaped sections, which are 9 in. high, ¾ in. thick in the web and ⅞ in. in the flange. These are nearly 30 ft. long in the clear between the flanges of the bolster section. Attention is called to this feature of

car is built just as in the case of any ordinary box car.

As the center sills alone are supported throughout their whole length by the casting, they are all stiffened and held in the ordinary way by six 1¼ in. truss rods. These truss rods pass through the end sill and then up over the posts *BBB* which are bolted to the top of the bolster of the steel casting. They then drop down under the king posts *DDD*. These are bolted to the underside of the needle beams which are



Plan and Longitudinal Section Through Center—One-Piece Cast Steel Underframe

the construction because all who are at all familiar with the art of casting steel will recognize the difficulty of making a casting of such magnitude and of having it free from imperfections. Both the top and bottom flanges are tied together at intervals by cross pieces of the same thickness as the flanges; in addition to which there are lugs as at *C C* with holes cored in them to which the longitudinal sills of the car are bolted. This makes essentially a box girder of these two sills, with a total sectional area of about 24 square inches or that of the standard requirements to sustain the pulling and buffing stresses to which the car may be subjected.

The bolster, cast integrally with the body of the sills, extends out on each side and with its smooth upper surface serves as a resting place for the sills.

The upper framing of the car is of wood and is carried on this underframe casting, very much as a container might be carried on a flat car.

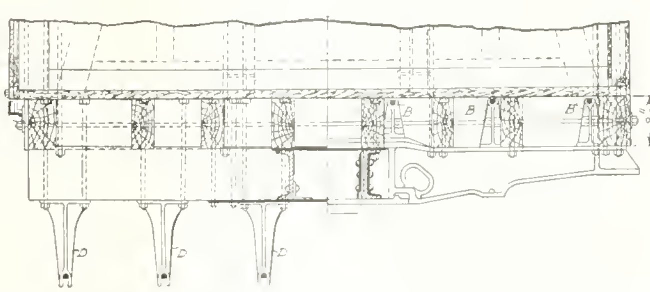
The general details of this construction are shown by the two half cross sections.

These show that there are eight longitudinal sills and that they rest on the main casting at the bolster and near the center are carried by two needle beams as is clearly illustrated by the reproduction of the photograph of the car.

It is on these sills that the upper framing of the

spaced 8 ft. apart from center to center at the center of the car as will be seen from the reproduction of the photograph; their total drop being about 31 in. so that the trussing effect is stiff and substantial.

As the needle beams serve only as a point of support for the king posts, it is unnecessary to carry them



At Center of Car At Bolster

Half Sections of Southern Pacific Box Car

all of the way across the car, and so they are cut off and fitted in to the side of the main casting, the space above them between the sills being filled in, and the needle beams themselves bolted both to the fillers and the sills.

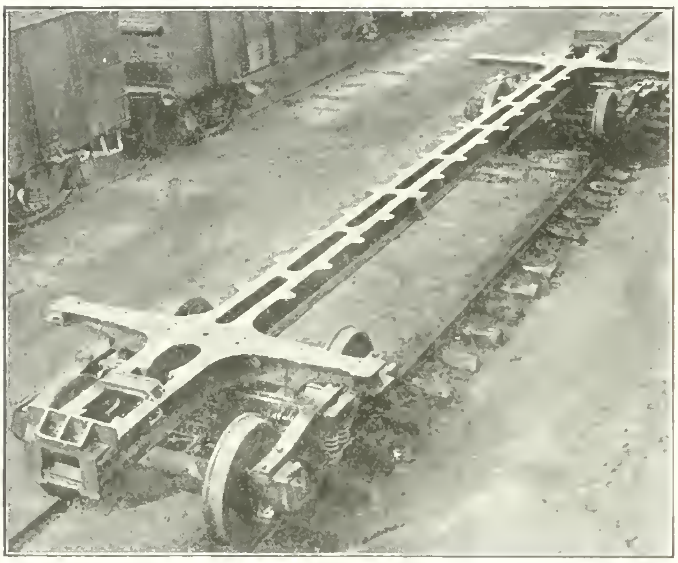
The whole weight of the car thus rests upon the main underframe casting and could, if necessary, be cast loose and lifted from it. And it is the casting that sustains all of the pulling and buffing stresses without putting any on the car framing at all. The design is believed to be unique, and is only possible of construction because of the ability of the steel foundrymen to make a casting of such large dimensions and of such thin sections.

Attention is also invited to the standard A. R. A. draft gear pocket which is 9 x 12⅝ x 24⅝, the brackets being cast as an integral part of the center sills, and in this one item alone 44 parts are eliminated at each end of the car, or a total of 88 pieces and parts ordinarily used in constructing a standard gear pocket.

From the illustration of the completed car it will be observed that is a double sheathed car with a cubic capacity of 3,370 cubic feet and 8,000 pounds. Its principal dimensions are as follows:

Height 13 ft. 3 in.
Width 9 ft., 4 in.
Length outside, 40 ft. 11 in.
Length inside 40 ft.

The weight of this particular car is 46,600 pounds, but the average weight of ten cars built to this design



One-Piece Cast Steel Underframe Southern Pacific Box Car

was only 46,400 pounds as compared to 46,273 pounds for standard box cars with built up center sills of same dimensions and capacity from which it will be observed that these cars with the cast steel one-piece underframe only weigh about 130 pounds more than those built up with the fabricated center member.

These cars are also equipped with "K" Triple Valves, type "D" coupler, shanks 6 x 8, friction draft gear, cast steel yoke, No. 2 brake beams, and dirt collectors. All ten of the cars are equipped with Allen doors, Murphy Flexible roofs, some are equipped with Symons friction draft gear and others with the Miner A-2-S friction draft gear.

This certainly marks an epoch in car design and construction particularly with respect to the use of cast steel for underframes in place of the built up or fabricated member and will be carefully watched by car designers, builders and railway officers alike to observe their behavior in service.

Much credit is given to the progressive officers of the Southern Pacific Company who made it possible for this advanced step to be taken in car design and construction.

American Red Cross Service Car

In an effort to reduce the number of deaths from injuries in the nation, the American Red Cross First Aid service car has started out over the Baltimore & Ohio system and in the five months it will spend on this company's lines it is expected that hundreds of thousands of railroad employes, industrial workers, Boy Scouts and others will be prepared to give efficient aid to those who have been injured.

This trip of the first-aid car, which began in Philadelphia July 21 last, marks the resumption of this sort of work by the American Red Cross after the suspension brought about by the World War. It is planned to cover the entire country and the railroads of the country will co-operate by carrying the car from place to place.

The car is of the standard Pullman type and contains a lecture room seating 50 persons. It is so arranged that in case of necessity because of some disaster, it can be converted into a hospital accommodating 30 patients. There is a surplus supply of food, blankets, stretchers and first-aid materials for any purpose the car may be called for. At the conclusion of the five-months' trip over the Baltimore & Ohio Railroad the car will go to the Illinois Central Railroad and then to other roads until the entire country has been covered.

Meetings will be held in all the railroad shops, freight houses, freight yards and other places where there are groups of workers. When possible, the force will be taken to the car's assembly room. Otherwise the demonstrations will be given in the shop or other buildings where the men and women can be assembled. When the car is in a city or town one of the doctors will make a tour of all the industrial plants and give talks on first-aid work. Police forces, fire-fighting companies, municipal employes and others will be shown approved first aid and resuscitation methods. There will be lectures for the public, when first aid for the home will be shown. Anyone desiring to learn approved methods for taking care of cuts, burns, injuries of any other kind, the resuscitation of persons overcome by gas or by falling into the water, will be welcomed to the car. In each city visited the surgeons and instructors on the car will announce when meetings will be held.

Officials of the American Red Cross have discovered that thousands of minor accidents lead to death or permanent injury primarily because no one was present at the time of injury to give efficient first-aid service. Proper application of remedies, bandages, tourniquet, etc., it is claimed, will many times save a human life and this is the primary reason for the undertaking of the trip by the Red Cross.

A Sixteen-Thousand Ton Train

The Great Northern recently established a record when a train of 16,360 tons was moved by one locomotive. Mallet engine No. 2022 hauled 125 loaded ore cars, from an assembly yard at Kelly Lake to Baden, Minn., a distance of 39 miles, where 25 more loads were added to the train and hauled to Allouez, a further distance of 64 miles. Between Kelly Lake and Baden the train was hauled up a 0.3 grade about three miles long. The train consisted of:

Ore, 150 cars, 87 tons each......	13,050 tons
Cars, 150 at 20 tons each.........	3,000 tons
Engine and tender............	270 tons
Caboose	10 tons
Superintendent's business car.....	30 tons
Total	16,360 tons

Atmospheric Conditions and Physiological Effects Produced on Trainmen by Locomotive Smoke in Tunnels

The Department of the Interior has recently investigated the atmospheric conditions in the tunnels of the Union Pacific Railroad in Utah and Wyoming by observations made from the cabs of freight locomotives. This work was conducted by the Bureau of Mines at the request of, and in co-operation with, the Union Pacific Railroad Co., and was brought about by several accidents to members of engine crews while passing through tunnels, from pollution of the tunnel air by exhaust gases from freight locomotives.

The object was to determine the cause of gassing accidents, by examining into composition of the air in locomotive cabs while passing through railroad tunnels; to learn the effect of these conditions on the engine crew, and to provide a means of protection for the men so exposed. Gas samples and temperature readings taken in the cabs of locomotives were used in studying the atmospheric conditions to which the locomotive crews were exposed. The symptoms and the physiological effects produced in men exposed to the atmospheres encountered were studied. The pulse rates and body temperatures were taken, and the determinations of the carbon monoxide content of the blood were made. Various methods for the prevention of gassing and for the protection of men therefrom were considered and tested, among which were the use of mechanical devices for deflecting the smoke away from the engine cab, and the use of various types of gas masks and breathing apparatus.

While this investigation is a part of the safety work of the Bureau of Mines in connection with hazards from atmospheres containing carbon monoxide (CO), the results are of particular value to railroads operating steam locomotives through tunnels, and are also valuable to other industries where atmospheres having poisonous gases or of a high temperature and humidity may be present. The results may be summarized as follows:

1. Of 40 trips conducted in cabs of locomotives while the trains were passing through tunnels, carbon monoxide was found to be present on 34 trips. Of these, 21 tests gave 0.01 to 0.10 per cent of CO, 8 tests gave 0.11 to 0.20 per cent, and 5 tests, 0.21 to 0.35 per cent.

2. The operation of 24 trains of approximately 2,000 tons each, in a normal running time of 6 minutes through the Aspen tunnel, showed the following cab temperatures: 114 degrees Fahrenheit (dry bulb), 111° (wet bulb), and a relative humidity of 90 per cent. The maximum dry-bulb temperature recorded on any of the 40 tests conducted was 136°, while the maximum wet-bulb temperature was 124°. The time consumed in the passage of the trains varied from 4½ to 25 minutes.

3. Physiological tests showed that an exposure of 4½ to 8½ minutes to atmospheres containing 0.05 to 0.29 per cent carbon monoxide produced in subjects a blood saturation of 5 to 18 per cent.

4. Pocket respirator and other types of gas masks, packed with soda lime charcoal mixtures, afforded protection against smoke and sulphurous gases. Carbon monoxide masks afforded protection against all of the gases encountered. Some discomfort was experienced in wearing gas masks in atmospheres of high temperature and humidity.

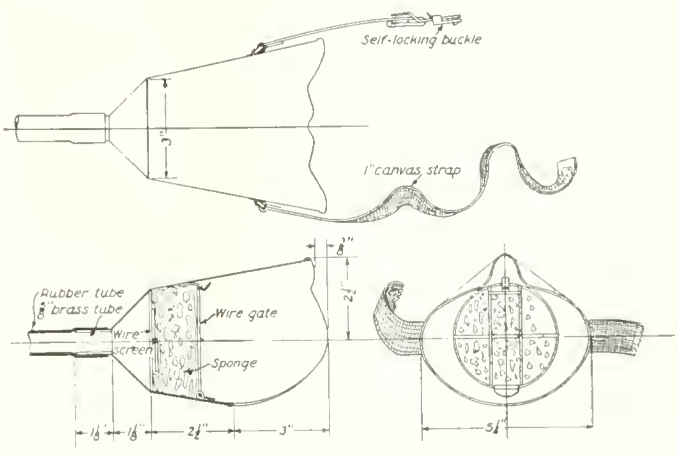
5. Temperature tests on the train air-brake pipe line showed increases of 4 to 41° in the temperature of the air in this line during the passage of a train through the tunnel. The temperature of the air in the train pipe was always 10° to 28° lower than the temperature of the air in the cab atmosphere.

6. Analysis of 11 samples of air taken from the train pipe as the train emerged from the tunnel showed no carbon monoxide in eight samples, and 0.01 per cent in three samples; while corresponding samples taken from the cab atmosphere showed from 0.0 to 0.18 per cent carbon monoxide.

7. Smoke deflectors or mechanical devices for deflecting the smoke from the locomotive cab, decreased the temperature of the cab atmosphere 20 to 30 degrees.

The conclusions reached are that:

1. Asphyxiation due to exposure to carbon monoxide, and exhaustion due to high temperatures and humidities,



Air line respirator.

Fig. 1.—Section and Plan of Air Line Respirator That Gives Wearer Free of Hands and Eyes

are the main causes of the accidents that have occurred in the tunnels investigated.

2. Results of physiological tests over periods of 10 minutes showed that the conditions in the cabs might be severe enough to cause asphyxiation or exhaustion in periods of 20 minutes, especially in cases where the engine is stalled.

3. If gas masks are used in the tunnels in which these tests were conducted, they should provide protection for the wearer against carbon monoxide. The results of tests by the investigator while wearing a mask proved to him that it was apparent that the feeling of discomfort was very much accentuated by unusually bad conditions, due to a combination of the effects caused by the altitude, high temperatures and humidities, and the time exposed. Whereas gas masks were feasible under less severe conditions it is doubtful whether they are applicable to this case.

4. The train air-brake line may be used as a source of air for breathing purposes for a period of 10 minutes. In combination with the air tanks in the train pipe, these acting as a reservoir, will afford a supply of pure air which will last 30 minutes.

5. The use of smoke deflectors provides an efficient

method for reducing cab temperatures, and will eliminate or minimize the danger from exhaustion resulting from high temperature and humidities.

As a result of this investigation the following recommendations are made:

1. For the purpose of reducing the hazards due to high temperatures, locomotives operating in the tunnel district should be equipped with smoke deflectors.

2. Respirators, attached to the train air line by one of the methods mentioned later, should be supplied to each member of the engine crew.

3. It would be advisable to shorten the time of passage of trains through the tunnels if possible. This might be done by not stopping heavy freight trains on ascending grades upon approach to the tunnels, and by increasing the speed limit to facilitate a quicker passage through the tunnels.

4. As victims of carbon monoxide poisoning require special and immediate treatment, it is recommended that engine crews, signal maintainers, and men working in vicinity of the tunnels be instructed in the use of apparatus and methods of first-aid treatment for such cases.

The physiological effects of locomotive exhaust gases are that the hot exhaust gases are the source of danger from exposure to tunnel atmospheres. Asphyxiation or exhaustion of the locomotive crews is caused by exposure to atmospheres containing carbon monoxide, or to atmospheres of a high temperature and saturated with moisture. The effects of one are accelerated and accentuated by the presence of the other; but perhaps the majority of the accidents are caused by exposure to carbon monoxides.

The above hazards are accentuated by a group of less importance consisting of sulphur dioxide, hydrogen sulphide, soot, and steam, accompanied by the decreased oxygen content of the air; and in the tunnels investigated, a low barometric pressure due to high altitude (6,600 to 7,200 ft.).

Carbon monoxide poisoning is brought about by the fact that carbon monoxide, when present in the air is taken into the lungs and combines with the red coloring matter (hemoglobin) of the blood. The subject, when exposed, is unconscious of the fact that the blood is being saturated by the gas; but at a certain point of saturation of the blood, about 60 per cent or less, the victim becomes unconscious, and collapses suddenly.

Strenuous exercise and high temperatures, accompanied by high relative humidities, induce greater lung ventilation and more rapid circulation of the blood, hence a more rapid absorption of carbon monoxide by the hemoglobin.

McConnell found the upper limit of man's ability to compensate for atmospheric conditions, when stripped to the waist and resting in still air, lies around 90° saturated. Above this temperature the body temperature and the pulse-rate increase, and undesirable physiological symptoms are produced. The pulse-rate is probably the best physiological index. The body temperature alone is not the cause of the discomfort. The subject complains of unbearable symptoms when the pulse-rate is increased above 135 beats per minute irrespective of body temperature.

During the course of this investigation it was concluded that a hazard from carbon monoxide was present in tunnel atmospheres. This is not the condition which was previously found on a similar investigation by Fieldner and others in the tunnels of the Baltimore and Ohio and Pennsylvania Railroads. Ventilation in these eastern tunnels was better due to greater side or top clearance, reduced time of exposure, or smaller motive power; therefore, the possibility of the presence of carbon monoxide was minimized. For use in these tunnels a small soda-lime charcoal respirator, which would not protect against carbon monoxide, was recommended. The canister gave protection against irritating smoke and gases, and carried with it a warning against its use in atmospheres which were likely to be contaminated with carbon monoxide.

Various types of soda-lime charcoal masks were used on the Union Pacific tests. The masks gave ample protection against sulphur dioxide and smoke; but there was a general complaint among the wearers in regard to the discomfort and difficulty of breathing through the masks. The men complained of the smothering effect and the exertion required to get a sufficient air supply. In the high temperatures and humidities encountered, there was an intense desire to throw off the mask so as to obtain relief from the smothering effect and so get more air, even at the risk of breathing the toxic atmosphere. The desire to take off the mask may be due to the effect of the high temperature, humidity, altitude, the added resistance to breathing, or the physiological effect produced by wearing the mask.

If gas masks are used in long and badly ventilated tunnels, they should afford the wearer protection against carbon monoxide gas. Such masks are now on the market, but they are hardly practical for use on account of the cost. The absorbent is efficient and active, but deteriorates upon exposure to moisture. For this reason the masks would require refilling after each trip. It would not be practical to use them intermittently for periods of short duration, during a number of days, such as would be required if used by railroad crews.

The most satisfactory method found for overcoming the tunnel atmospheres was by supplying air to the members of the engine crew through respirators attached to the train air-brake pipe line. A supply of air was led from the pipe by means of a rubber hose, which was, in turn, attached to an ordinary funnel. During the passage of the locomotive through the tunnel the wearer held the funnel to his face, and breathed fresh air supplied from the train pipe. The supply of air was regulated by a small orifice and valve. With this protection the wearer was able to breathe normally, without regard to the composition of the tunnel atmosphere. Figure 1 shows the section and plan of a modified air-line respirator, which gives the wearer free use of the hands and eyes.

From the results of the tests made to determine the purity and the temperature of the air supply, it was determined that the respirator would supply air for a period of 10 minutes, directly from the train air line, before it showed any marked contamination caused by the air-pumps working in the contaminated tunnel atmosphere; and that the increase in temperature of the air from the train pipe was not necessarily an indication that the air line was being contaminated.

In order to insure a pure air supply for a longer period, three of the four air-tanks under the running board on either side of the engine can be used in conjunction with the supply taken directly from the train pipe.

Three tanks, having a capacity of approximately 150 cubic feet of air, are sufficient to last three men 20 minutes. The tanks may be temporarily cut out of the train line and used as a reservoir for supplying air to the men in case of emergency. The air supply may be secured by short-circuiting the train air-line around the tanks by installing two three-way valves and a line across the boiler.

In regard to the use of protection for the men, it was the consensus of opinion of the observers, and also of the men operating trains, that the air-line respirator, in conjunction with the smoke deflector, gave protection to the men, which was more comfortable and practical than that afforded by the gas mask.

It was noticed throughout the tests that the men resorted to the use of the air-line respirator, cotton waste, handkerchiefs, and other means of protection, only when driven to it by extremely bad atmospheric conditions.

With this condition existing it is improbable that the railroad men would take care of or use the masks if the company furnished them.

The air-line respirators have several advantages over the gas mask—namely, (1) air is furnished to the wearer at atmospheric pressure; (2) there is no added resistance to breathing, no absorbent, refilling, maintenance cost, or supervision required; and (3) the funnels may be constructed of heavy material which will withstand the rough usage on locomotives. Three respirators should be allotted to each locomotive, and approximately 500 masks or 300 funnels would be required for the men on 100 engines.—Reports of Investigations, Department of the Interior, Bureau of Mines.

Heating of Car Wheels on Grades

A Study by Which the Tests of the Bureau of Standards and the University of Illinois Are Compared to Corresponding Work in Service

By GEO. L. FOWLER

The heating and consequent cracking of car wheels on grades because of the application of the brakes, has been one of the serious troubles that has arisen because of the development and extended use of the high capacity car.

The cast-iron wheel has had less change made in it than any other detail of car construction since the days when tare and load balanced each other at ten tons each. At that time a brake-shoe pressure of 200 lbs. per shoe would have been sufficient to hold a car on a one per cent grade. Now, under the same conditions, it takes 700 lbs., with the result that wheels are overheated in the rim; and the difference in temperature between rim and hub sets up stresses in the plates that are apt to crack them. To avoid this cooling stations are established on long grades where trains are stopped and held for wheels to cool or, rather, where their variations in temperature are permitted to equalize and thus modify or annul the stresses that would otherwise be set up in the plates.

As to just what difference in temperature between the hub and the plate will cause a wheel to crack, depends, of course on the character of the metal in the wheel subjected to this difference.

According to the tests made by the Bureau of Standards, as reported in Railway & Locomotive Engineering for June, 1922, certain wheels cracked where the difference in temperature between the rim and hub was only 289 degrees; whereas, in the case of the tests of the University of Illinois, differences as great as 603 degrees Fahr. were developed without cracking. The stresses that were calculated as having been possibly set up in these wheels as published in a previous article in the June, 1923, issue of this paper show them to have been in excess of the tensile strength of the metal in some of these wheels. Hence it is fairly safe to assert that a difference of 300 degrees Fahr. between the temperature of the rim and the hub, place it in the danger zone where it is liable to crack.

It should be borne in mind that in the case of the tests at both the Bureau of Standards and the University of Illinois, the wheels were quiescent during the period of test. That is, they were not subjected to shock as they are when running under a car; a condition that adds to the stresses sustained and which would add to the danger of breakage. As to what this amounts to we have no information. It can, therefore, simply be classed as an unknown quantity that must, nevertheless, be reckoned with.

The braking tests, as reported in the bulletin of the University of Illinois were exceedingly severe, as the brake application was continuous for the time and distance stated in the tables and shown in the various diagrams.

In order to convert these laboratory investigations to an equivalent of grade work, we have simply to remember that, in lowering a car down a grade at a uniform speed the total average of brake and other resistances must be equal to the total weight of the car multiplied by the percentage of the grade.

If, then, we assume a car to weigh 140,000 lbs., the weight on each of its eight wheels will be 17,500 lbs. So that if, in this case, we multiply the brake-shoe pressure by the mean coefficient of friction and divide by 17,500, we would have the grade for which that particular brake-shoe pressure would be adapted, in the case of a car weighing 140,000 lbs.

In the accompanying table the column of equivalent grades shows those corresponding to the runs that were made and the column of maximum temperatures of the rim shows the results of this prolonged and heavy brake-shoe pressure as far as these temperatures were reported in the bulletin.

It is needless to say that no engineer, in his senses, would think of negotiating such grades at such speeds with a long and heavy freight train. For example a run down a 2.17 per cent grade for a distance of nearly 10 miles at a little less than 50 miles an hour is an unheard of performance. This run occupied 12 minutes and the heat developed in the rim amounted to 568 degrees Fahr., with a differential between it and the hub of 444 degrees. Such a condition would be regarded as a dangerous one in service. Yet the wheel sustained the stresses developed by the differences in temperature between the rim and the hub in the laboratory.

It is doubtful if it would have done so had it been subjected to the pounding action of a running car.

These tests were made with a continuous brake application, which accounts for its severity; whereas, in ordinary grade braking the application is intermittent.

In order to determine the effect of intermittent brake action, certain tests were run with the brake applied for 190 revolutions of the wheel and released for 610 revolutions. This went to the opposite extreme for the shoes are never fully released on a heavy grade, unless the brake-cylinder air leaks off because of a defective retaining valve.

In a test made to determine the effect of this intermittent brakeshoe action it was found that the rise of temperature in the rim was very rapid during that application and that the fall in temperature was almost equally as rapid with the brake released.

The method of conducting the test was to bring the wheel up to a speed of 20.39 miles an hour, apply the brakeshoe with a pressure of 2,008 lbs. for a period of 10 minutes, then stop the wheel for a strain reading and then accelerate to speed and repeat the work until a distance of 20.39 miles had been traversed. In this the elapsed time from the instant of the removal of the pressure to its reapplication was five minutes, and the total elapsed time from the first application to the last release was 85 minutes.

Here we see that the rise of rim temperature was rapid and was followed by an almost equally rapid cooling, there having been a total rise of about 1,067 degrees in 60 minutes and a total fall of about 538 degrees in 25 minutes, leaving a net rise of about 529 degrees and a final temperature of 629 degrees.

The temperature of the hub meanwhile was subjected to a slow and steady rise, with a more rapid increase after the end of the last application. This illustrates the flow of heat from the rim toward the hub, even during the period of brake release. And this is well illustrated by the rise of hub temperature even after the rim had started to cool.

This matter of heat radiation from the rim of the wheel, and the variations that might occur was brought out in some of the testimony at the power brake hearing in Washington.

The testimony was in regard to certain examinations that were made as to wheel temperature at the foot of a grade. As time was occupied in moving from car to car to do this work, it was recognized that the wheels would be cooling during the interval between the stop and the time of taking the temperature.

In order to draw a curve representing this cooling, a wheel that was hot at the instant of stopping was selected, with the intention of taking its temperature at short intervals and from this data building up a diagram by which an estimate might be made as to what the temperature of a wheel might be when it stopped, even though it might be fifteen or twenty minutes afterwards that its temperature was taken.

In the particular case cited, the rim of a wheel, on stopping, had a temperature of 210 on the tread. A reading was taken every 30 seconds. At the end of three minutes, its temperature at the surface of the tread had risen to 260 degrees and then it began to fall.

At the end of five and a half minutes, the engine, which had gone to the water tank, came back and, in coupling to the train, so bumped against it that the wheel, whose temperature was being taken, was given a quarter turn, so that the location of taking the temperature was changed, and at the fresh spot the temperature read 280 degrees.

The temperature then rose so that seven minutes after the train had stopped the temperature of the wheel was 295 degrees. It then fell gradually, but even when the train pulled out 10 minutes after its stopping time, the apparent temperature at the rim was 226 degrees, or 16 degrees higher than when the train stopped, despite the fact that the wheel had been radiating heat during the whole period of the stop.

The explanation given for this was that there had been a chilling effect on the surface of the rim, as it rolled down the grade under a reduced application of the brake, and that it was this cooled tread surface that was first measured. Then, the heat that had been stored in the body of the wheel began to come out and the temperature of the surface rose until the rate of radiation exceeded the rate of convection, when the temperature started to fall. Of course, under these conditions, the proposed diagram could not be drawn.

The same thing was brought out in the temperature determinations of a running wheel on the Virginian a number of years ago. In several cases the temperature of the rim was less at the end of a run than it had been at intermediate points on a descending grade because of the partial release of brakeshoe pressure.

The point is to show that, while, in the cases given, the brakeshoe applications were abnormally severe and are exceedingly valuable in indicating the stresses to which the wheels were subjected in the tests, they are not duplications of road service, which is of such a character that such applications would probably result in cracked wheels.

But inasmuch as these tests of the University of Illinois when taken in connection with those of the Bureau of Standards may be made to show the stresses developed by various differences in temperature between the rim and the hub, it would be well to extend this investigation to wheels in service and determine as to just what these differentials are apt to be on some typical grades where trouble is experienced because of overheating as as a result of a long-continued brake application.

University of Illinois Braking Tests on Cast Iron Wheels Equated for Equivalent Road Service

Brakeshoe Pressure, Lb.	Speed Miles Per Hour	Maximum Temperature of Rim, Deg. F.	Distance Run With Brakeshoe Applied, Miles	Mean Coefficient of Friction	Temperature Difference Between Rim and Hub, Deg. F.	Equivalent Grade in Per Cent	Time Occupied by Test, Minutes
Tests on 33 in.—650 Lb. Arch Plate Wheel							
Wheel Slightly Eccentric							
2,019	9.98	560	19.95	0.34	332*	3.95	120
2,023	19.96	...	19.96	0.26	469*	3.00	60
2,022	30.06	...	15.03	0.20	284*	2.31	30
Wheel Ground True							
2,019	9.98	...	19.96	0.39	375*	4.49	120
2,015	19.93	...	19.93	0.27	437*	3.11	60
2,016	29.84	724	14.92	0.23	595*	2.65	30
2,014	39.88	...	9.97	0.21	375*	2.42	15
2,015	49.75	568	9.95	0.21	474*	2.42	12
Tests on 33 in.—725 lb. M. C. B. Wheel							
[illegible]	10.01	596	20.02	0.35	340	4.01	120
2,003	19.95	...	19.95	0.26	427	2.90	60
2,002	30.00	608	15.00	0.21	485	2.63	30
1,999	39.92	...	9.98	0.21	327	2.39	15
[illegible]	49.75	516	9.95	0.19	444	2.17	12
Tests on 33 in.—750 lb. M. C. B. Wheel							
[illegible]	[illegible]	600	20.04	0.34	[illegible]	3.91	[illegible]
[illegible]	19.98	...	19.98	0.26	395	2.98	60
[illegible]	30.00	580	[illegible]	[illegible]	455	2.75	[illegible]
[illegible]	[illegible]	...	9.98	0.20	443	2.29	15
[illegible]	[illegible]	440	9.97	0.21	340	2.39	12
Tests on 33 in.—750 lb. Arch Plate Wheel							
[illegible]	10.01	[illegible]	20.02	0.32	317	3.69	120
[illegible]	[illegible]	...	19.99	[illegible]	382	2.64	60
[illegible]	[illegible]	[illegible]	14.91	0.18	461	2.06	30
[illegible]	[illegible]	...	9.99	0.17	[illegible]	1.94	15
[illegible]	[illegible]	[illegible]	10.00	0.17	417	1.95	[illegible]
[illegible]	[illegible]		14.77	[illegible]	515	1.84	30
[illegible]	[illegible]		[illegible]	0.19	540	[illegible]	30
[illegible]	[illegible]		[illegible]	0.18	[illegible]	[illegible]	15
[illegible]	[illegible]		9.70	0.17	[illegible]	[illegible]	12
[illegible]	[illegible]		9.86	0.17	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	0.16	542	2.15	12
[illegible] in.—950 lb. Arch Plate Wheel							
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		10.03	[illegible]	[illegible]	[illegible]	60
[illegible]	[illegible]	[illegible]	[illegible]	0.27	[illegible]	1.51	60
[illegible]	[illegible]		[illegible]	[illegible]	350*	1.77	90
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	2.03	30
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	150	40
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	1.66	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.33	30
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.43	24
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	12
[illegible]	[illegible]	[illegible]	[illegible]	0.36	[illegible]	4.11	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	60
[illegible]	[illegible]	568	[illegible]	0.28	314*	[illegible]	60
[illegible]	[illegible]	...	[illegible]	[illegible]	[illegible]	3.34	30
[illegible]	[illegible]		[illegible]	[illegible]	350*	3.34	90
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40
[illegible]	[illegible]		[illegible]	0.24	[illegible]	[illegible]	20
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	457*	[illegible]	30
[illegible]	[illegible]	608	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	12
[illegible]	[illegible]	732	[illegible]	[illegible]	[illegible]	6.19	120
[illegible]	[illegible]		[illegible]	0.34	334*	5.81	60
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.63	60
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.17	30
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.43	40
[illegible]	[illegible]	[illegible]	20.10	[illegible]	540*	3.09	30
3,015	[illegible]	[illegible]	[illegible]	[illegible]	473*	2.93	24

*Difference in temperature between rim and midway of outer plate.

Mikado Type Locomotives for the D. & I. R. R. R.

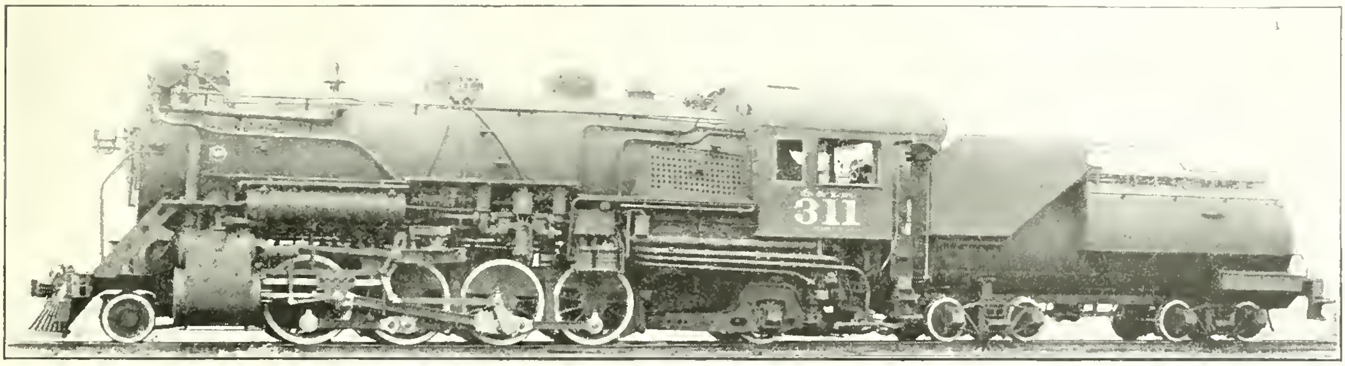
The Duluth and Iron Range handles a heavy ore traffic from the Mesabi Range district in northern Minnesota to the port of Duluth at the western end of Lake Superior. The grades are generally favorable to the southbound movement, and this permits the operation of heavy tonnage trains, the empties being hauled northbound on the return trips to the mines.

Previous to 1913, the heaviest locomotives used in this service were of the Consolidation type with 22 x 28-inch cylinders and driving-wheels 54 inches in diameter. These locomotives weighed 198,850 pounds in working order, and developed a tractive force of 42,700 pounds. They used saturated steam and were equipped with slide valves. With a constantly increasing traffic demanding larger train loads and heavier power, the road, in 1913, placed in service four Baldwin Mikados which used superheated steam, weighed in working order 285,000 pounds, and developed a tractive force of 56,000 pounds. These were followed in 1916 by three more Baldwin locomotives of similar type, but having larger boilers and carrying a higher steam pressure; and now three additional Mikados have recently been completed and placed in service. These new locomotives, designated as Class N-2, have the same general dimensions as those built in 1916, but the details have been carefully revised and the equipment includes several appliances not used on the previous locomotives. Most notable among these are a feed-water heater and a booster. With the aid of the latter, the tractive force is increased, at starting speeds, from 59,400 pounds to approximately 70,000 pounds, thus ranking these Mikados among the most powerful of their type thus far built. The booster is piped to use superheated steam, and its exhaust is discharged through the main exhaust nozzle in the smokebox. It is carried on a trailing truck of the Delta type, designed for application in combination with the Commonwealth rear frame cradle.

The boiler is fed by one Nathan non-lifting injector of 5,000-5,500 gallons capacity, placed on the right-hand side, and by one feed-water heater and pump of the Superheater Company's closed type, placed on the left-hand side. The Seddon boiler-feed device is applied for the purpose of depositing the scale-forming ingredients in the water before the latter is finally discharged into the boiler.

These locomotives are fired with Duplex stokers, and are equipped with air-operated fire-doors and power-operated grate-shakers. The arch is supported on five tubes, each 3" in diameter. The superheater is of the usual top-header type, with 45 elements which are placed in as many 5⅜" tubes.

The Walschaerts valve gear is applied, and is controlled by the Ragonnet type E power reverse mechanism. The valves have a steam lap of 1 1/16" and are line-and-line on their exhaust edges, and are set with a maximum travel of 6" and a lead of 3/16". They are of the built-up type, with spools and followers of cast steel. The piston-heads are of solid rolled steel and the guides and cross-heads are of the Laird type. The piston rods are attached to the cross-heads with heat-treated steel keys.



Mikado Type Locomotive for the Duluth and Iron Range Railroad

As far as capacity increasing devices are concerned, these are among the most completely equipped locomotives thus far built, and their performance on the road will be watched with interest. In view of the fine work that is being done by the previous locomotives of this type, there is every reason to believe that they will prove successful.

Gauge	4' 8½"
Cylinders	27" x 30"
Valves	Piston, 15" diam.

BOILER

Type	Wagon top
Diameter	88"
Working pressure	185 lb.
Fuel	Soft coal

FIREBOX

Material	Steel
Staying	Radial
Length	112"
Width	96"
Depth, front	90 1/16"
" back	67 5/16"

TUBES

Diameter	5⅜"	2"
Number	45	304
Length	19' 5"	19' 5"

HEATING SURFACE

Firebox	241 sq. ft.
Tubes	4301 sq. ft.
Firebrick tubes	38 sq. ft.
Total	4580 sq. ft.
Superheater	1072 sq. ft.
Grate area	74.6 sq. ft.

DRIVING WHEELS

Diameter, outside	58"
" center	51"
Journals	10½" x 12"

ENGINE TRUCK WHEELS

Diameter, front	30"
Journals	6" x 12"
Diameter, back	42"
Journals	9" x 14"

WHEEL BASE

Driving	15' 9"
Rigid	15' 9"
Total engine	35' 0"
Total engine & tender	71' 1½"

WEIGHT

In Working Order

On driving wheels	240,090 lb.
On truck, front	22,250 lb.
" " back	59,070 lb.
Total engine	321,410 lb.
Total engine & tender	503,000 lb.

TENDER

Wheels, number	8
" diameter	33"
Journals	6" x 11"
Tank capacity	9,000 U. S. gal.
Fuel "	14 tons

Tractive force	59,400 lb.
Service	Freight

The Training of Apprentices

Individual Paper Read at Mechanical Division Meeting of the A. R. A.

By JOHN PURCELL, Assistant to Vice-President, Atchison, Topeka and Santa Fe Railway

Apprenticeships have existed in some form for many centuries. Years ago before the advent of our present diversity of trades and occupations, when one blacksmith did all the metal work for the community, or when one carpenter, one millwright or one painter was all that was needed in the immediate vicinity, a boy was taken in by this artisan, became a part of his family, and through close association, working with his master, absorbed the work and in turn became an artisan. As commerce and population grew, the need of greater production was manifested, the number of artisans was increased, gradually changing into our present system of industry. Apprenticeship grew with industry and we see the development of a more definite plan for training workmen. The growth in industry and the great and rapid increase in demand for its products made a corresponding increase in demand for skilled workmen, the class of workmen which only a well-defined apprenticeship can supply. There are not enough skilled mechanics to supply the demand today, nor have there been for the past twenty years. This is why some of the railroads have found it necessary to devise a modern, progressive plan for educating and training apprentices in their shops. The older method of employing a boy and placing him in the shop, turning him over to a busy foreman, whose primary duties were immediate output, affording him little time to care for a green, bashful boy, was very unsatisfactory and failed to accomplish needed results. The boy being left to his own resources, with no one definitely responsible for his training, only a few of the more ambitious and resourceful survived and became good men; the majority fell by the wayside. It is evident since we specialize with various elements of a shop—a separate tool room for making and caring for tools, a central power house to provide power and lights, an accounting and timekeeping department to determine costs—that we should have a specialized plan for taking care of our young help that will provide a trained head and hand for our skilled work.

Today a boy over sixteen and under twenty-two comes to us to learn a trade. We examine him as to his mental alertness, education, character, etc., and endeavor to learn whether he has natural fitness or liking for the trade he wishes to learn. We also have a surgeon examine him to be sure he is free from physical ailments or organic trouble which would make him unable to perform the work of a mechanic. Company, state, and federal rules of inspection, safety appliance laws, rules of interchange, etc., make it necessary that a worker be able to read a blue print intelligently and to interpret these rules with reasonable understanding. Many of the states have compulsory school attendance laws and in these days a boy of sixteen years should have a well-grounded training in mathematics.

An apprentice training system should be composed of two supplementary branches, shop training and school training. The road with which I am connected has for sixteen years conducted such a training course for apprentices and while for the first two or three years it was considered as an experiment, it has become a fixed part of our mechanical organization.

Classes of Apprentices

We have three general classes of apprentices, known as Regular Apprentices, Helper Apprentices and Special Apprentices.

Regular Apprentices must be between the ages of sixteen and twenty-two, must be physically fit, have a common school education and be capable of working ordinary problems involving common and decimal fractions. Each is regularly indentured to serve four years, the necessary papers being formally signed by his parents or guardian, who obligate themselves to assist the employer in training the boy, by their parental encouragement and care. He is examined by the apprentice instructors as to his mental qualifications and alertness, and his employment completed by local Master Mechanic or Superintendent Shops, with the approval of Mechanical Superintendent and Supervisor of Apprentices.

Shop Instruction

The apprentice is passing through a critical stage of life, from boyhood to young manhood, is easily influenced, habits quickly formed, and it is well that a strong but kindly hand guide his steps and direct his youthful energy and ambition in correct paths. Here is where the shop instructor proves his value. No time is lost by the boy in getting started. He is immediately put on productive work under the training and guidance of the Apprentice Shop Instructor. If a Machinist apprentice he is immediately taken to a machine and the machine explained to him. He is shown how to fasten his work on the machine and what speed and feed to use, patiently and thoroughly instructed as to each machine, its parts, its functions, its care and how it should be operated. He is made familiar with the purpose for which the piece of work is being made and the use to which it is to be put. Similar instructions are given him as to floor and bench work and all other work of his trade. A regular schedule of shop work is provided showing the number of months or weeks he is to be assigned to each class of machines or each class of floor or bench work. Likewise, with apprentices of other trades. Each is given instruction and experience on each class of work of his trade. The apprentice is never considered as a matter of convenience nor assigned to common labor or regularly used as a helper. We make him feel that his chosen trade is the best possible selection he could make. We hold the instructor responsible for the boy's thorough training just as we hold the foreman responsible for the output of the shop. For every twenty-five apprentices there should be a regularly assigned Shop Instructor whose sole duties should be the training of the apprentice, instructing him in each branch of his shop work, instructing him as to the parts of the machine, its care, maintenance and operation, the grinding and setting of the cutting tools, the correct speed for various metals, chucking and clamping work for machining, approved methods of bench and floor work, precautionary rules of safety and the maximum production consistent with quality and a thorough understanding of the work. The shop foreman has little time to devote to a young apprentice boy. He is too busily engaged in obtaining maximum output to instruct an apprentice and to change him from one class of work to another, and is prone to leave him on one job or machine. A good shop instructor is a good investment in any shop. Due to his instruction, better work is done by the apprentice, there is very little defective work, an absence of tool breakage and the great advantage in being able to keep important machines going when regular operator is absent, by placing an apprentice on the machine, who with the help of the instructor can successfully operate same. A good shop instructor will study each boy, weeding out the unfit, advancing the bright, aggressive boy, and coaching the backward boy.

School Instruction

In connection with his shop training the apprentice should receive some theoretical instruction, so we have provided regular apprentice schools which the apprentices are required to attend four hours per week in two classes of two hours each, a total of 208 hours per year. Here the apprentices are taught mechanical and freehand drawing, shop mathematics, company and federal rules governing the care and maintenance of equipment, the company standards as to materials and practices, is given an opportunity for reading and studying desirable text books on mechanical subjects, and for a detailed study of injectors, lubricators, air brakes, steam heat, stokers, and other special appliances. Regular apprentices are paid their regular rate for time attending school. The company provides drawing boards, instruments, stationery, lesson sheets, models, charts, books, etc., free of charge, each apprentice being provided with a complete outfit for his use while attending this school. Our apprentice school instructors are in general technically educated men who have also served an apprenticeship in our shops. In addition to his duties as instructor, he supervises the making of all shop sketches and drawings and looks after special and technical work for his Master Mechanic. He is supplied with literature on new appliances, with which he must familiarize himself in advance of their application. We print our own lesson sheets in drawing and mathematics, these bound in loose leaf form and kept constantly up to date. Upon completing this school course, the apprentice is not only able to read blue prints and working drawings readily and understandingly but can also make sketches and finished drawings. In fact, in addition to being a skilled mechanic he is also qualified for work as a mechanical draftsman.

Apprentice Boards

The fate of an apprentice should not be left to any one man so we established what is known as the "Apprentice Board," a body of men composed of the general foreman as chairman, the department or gang foreman under whom the apprentices work, and the apprentice school and shop instructors. These men meet once a month at stated times to pass on the progress of apprentices and discuss matters pertaining to their training. They go into each case carefully and thoroughly, strengthening the weak and encouraging the strong. In spite of all the care that is taken, there are times when we find a boy who is not making the progress he should. In such cases we endeavor to learn the reason, the boy being talked to and urged to greater effort. If it is found that he continues below the standard and does not take the right interest, he is tried on another trade and if he then does not develop he is dropped from the service. These apprentice boards serve a dual purpose, that of learning of the progress and ability of each apprentice and of making each member of the board study his men more closely and keep intimately familiar with the qualifications and progress of each individual under him.

Thorough experience is given all apprentices. Apprentices of the larger back shops are required to serve six months in roundhouses or at smaller outlying points and apprentices at smaller points are sent to larger shops where a more extended opportunity is afforded. Every effort is made to see that each apprentice is given full variety of experience in all the work of his trade so that upon graduation he may be a skilled, all-around mechanic who can execute and lay out any piece of work from any drawing furnished him.

Helper Apprentices are selected from young men who have had two years' experience as helpers of the craft. They serve three years and are given the shop instruction and variety of work given regular apprentices. They are not compelled to attend the apprentice school but are permitted to do so if they so desire. This apprenticeship provides opportunity for advancement of some of the most deserving helpers in our shops.

Special Apprentices are graduates in Mechanical Engineering from colleges and universities. They are employed upon a personal interview by Supervisor of Apprentices and must pass the same medical examination as the regular apprentices. As they have a thorough technical education and generally have had some shop experience, this course is made shorter than that of the regular apprentice. They are formally indentured for three years. Their course in the shop is short and intensive. First year, general machine work. Second year, floor and erecting work. Third year, work of a varied nature, consisting of four months in roundhouse, two months in boiler shop, two months freight car work, two months in power plant and two months with the Road Foreman of Engines. They are required to pursue a course of reading as laid out by the Management and to write a monthly letter bearing on the work they have been doing. The purpose of this special apprentice course is to supply the practical experience, without which the college man's education is of little value in railroad work. We have some excellent material now as special apprentices and are in the market for more of them.

Shop Tools

A standard set of shop tools of the trade must be owned by each apprentice of that trade. The company provides an easy method of payment at wholesale price and furnishes a tool box for their safe keeping. This insures uniformity and places each boy on the same footing.

Athletics, Etc.

Apprentices are encouraged in athletics, clean sport and wholesome amusement aiding in the boy's development. Baseball, football, basketball, etc., are played in their regular season. The apprentices also have their musical societies, their social and debating clubs. We aim to make our boys not only first class skilled mechanics but also good citizens, of moral character and right living.

Diplomas

Upon graduation or completion of apprenticeship, the apprentice is given a handsome diploma certifying that he has served an apprenticeship in the shops of this company, has completed the prescribed course in the apprentice school and has become a competent and skilled mechanic. This diploma is signed by the master mechanic or superintendent of shops, the mechanical superintendent, the supervisor of apprentices and the chief mechanical officer of the system. Often the lettering on this diploma is made by the boy himself.

General Results

From sixteen years' experience in this course of training, we have satisfied ourselves that this is the only method to pursue to keep our railroad supplied with first class mechanics. We have no industrial territory to draw upon for men. Immediately upon inaugurating our present apprenticeship system we began to enjoy its benefits. It furnished skilled mechanics for our shops. Just prior to the war our largest shop had not employed a mechanic from the outside for two years. We were making mechanics as fast as we needed them. It gave us a flexible body of young men whom we could transfer to any point where men were needed due to any unusual rush of business. It furnished staff officers and inspectors and best of all, gave us an almost unlimited source to draw upon for supervisory officers. Today with all the discouraging conditions of the past few years, we have over 200 of our graduate apprentices filling supervisory positions in our shops, from gang foremen to master mechanics, and a large number in important staff positions.

In establishing and properly conducting an apprentice system, there are several essentials for its successful operation:

(1) Some individual head who shall have general supervision in the selection of apprentices and their shop and school training.

(2) Ample shop instructors whose sole duties are to train and direct the boys while in the shop.

(3) An efficient school room instruction where the theory of the trade will be taught the apprentices by capable and intelligent instructors.

(4) The backing and support of the Management.

These are necessary for the development of the apprentice. The head should prepare necessary rules to insure a standard method of employing, standard lesson sheets for school room work, a regular fixed schedule for shop work to avoid partiality and to insure an equal opportunity to each. He should see that competent instructors are employed and should keep a faithful record of all apprentices while serving their time and an equally complete record of those who have completed the course and have been assigned to regular work and a list of all graduates available for promotion. You must not expect an apprentice training system to go on and give results without some one whom you can depend upon to carry out its purpose.

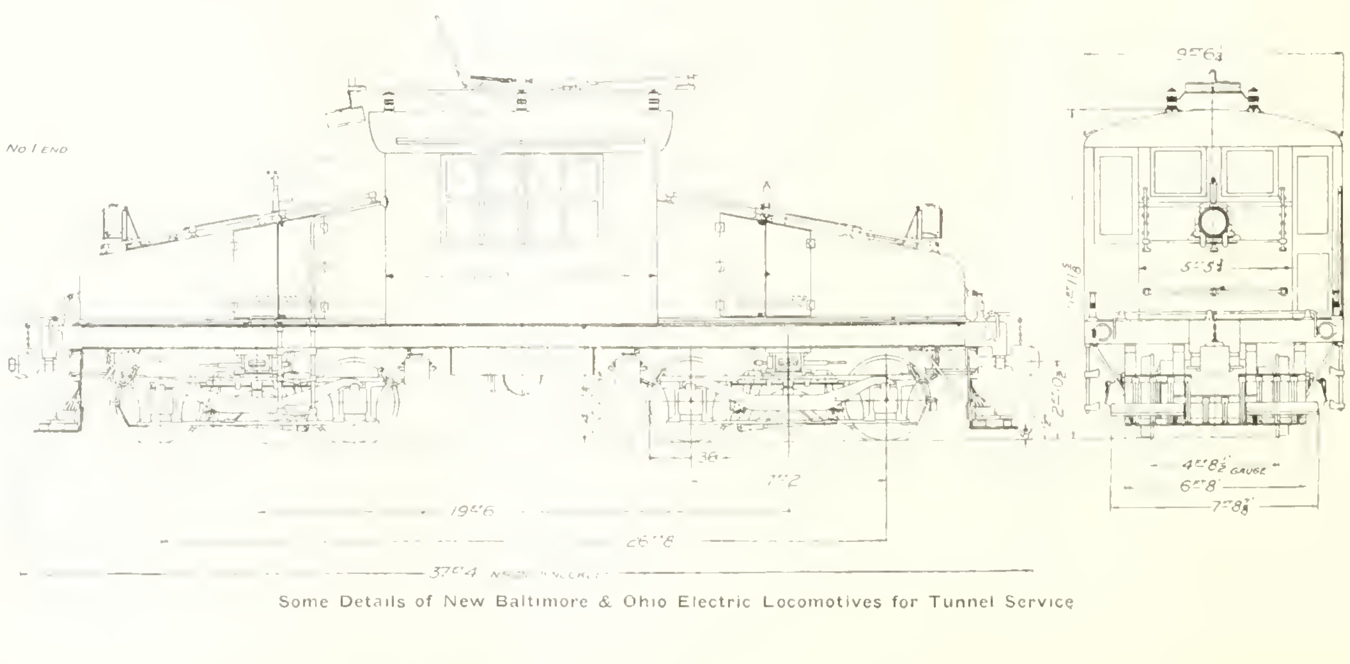
Railroads should make and promote their own men and not depend upon other roads to furnish them. The thorough training of apprentices should have the backing and support of the chief mechanical officer, for it insures him of having not only skilled mechanics for the shops but of having men trained and qualified to fill any position of a supervisory nature that may become vacant in his department. As a matter of fact, every officer owes it to his company and to his superior officer to have men trained and qualified to fill any position that may arise. He should have some one under him thoroughly qualified, familiar with the property, the rules and regulations, trained and ready to take his position whenever the necessity arises.

New Electric Locomotives for B. & O. Tunnel

The latest shipment made from the Erie factory of the General Electric Company is that of two 120 ton, 600 volt locomotives for the Baltimore tunnel of the Baltimore & Ohio Railroad. They are of the steeple cab type with articulated trucks and each equipped with G-E 209 motors. The length of the locomotives inside knuckles is 39 ft. 6 in., length over cab, 33 ft. 6 in., height over cab, 12 ft. 4 in., overall width 10 ft. The dimensions of the operating cab is 15 ft. by 10 ft.

A feature of the construction is that buffing and hauling stresses are carried through the truck side frames and an articulated joint, thus entirely eliminating these strains from the cab and platform. Multiple unit control and four third rail shoes are provided.

These locomotives have been designed for a speed of 17 miles per hour with train of 1200 tons and 14 miles per hour up a 0.5 grade. The tractive effort is 21,600 pounds.



Some Details of New Baltimore & Ohio Electric Locomotives for Tunnel Service

Locomotive Development as Evidenced by Sustained Efficiency and Long Runs

We frequently read comments from those who claim to be authority on the development of American railways that the locomotive of today is practically the same as the first one built in 1832 except in size, but on analysis such statements are generally found to come from those who have not acquainted themselves with the fundamental facts in connection with the subject treated.

It is quite true that in the earlier history of our railways the runs were very short and quite properly so, for the roads or lines upon which the engines operated were short, and much, if not all of the travel for many years was only during daylight and even after the lengths of the lines had been extended beyond what was an ordinary day's travel by rail many of the trains stopped at night pretty much as stage coaches were in the habit of doing.

As the country developed the locomotives were not only improved, providing larger tenders with capacity for greater amount of fuel and water, methods of lubrication were so improved as to prevent heating of the journals and points for exchanging locomotives were extended from the earlier distance of 30 to 35 miles up to 75 and 100 miles, and for many years 100 miles per day was considered a fair distance for a locomotive, and terminal points were, so far as possible, arranged at about this distance apart.

With the introduction of various economies necessary in railway operation many managers some 15 to 20 years ago, and even some farther back than that period, sought to secure greater locomotive mileage by extending passenger runs over two or more freight divisions, and while this originally met with considerable opposition from the engine crews as well as local interests at terminal points or shops where roundhouses were located, yet it was found that where an honest effort was made by all concerned much economy could be effected in this manner. More than 30 years ago on one of the western districts of the Santa Fe system, passenger engines were run through 350 miles over about the most difficult desert country with which railways have to contend, these engines were then doubled back 240 miles, making almost a continuous run of 590 miles, and although this was successfully accomplished for quite a considerable period of time, such opposition prevailed that the runs were considerably shortened.

In 1894 two prominent superintendents of machinery reported to the Master Mechanics' Association that they had succeeded in making continuous runs of 135 to 140 miles with a standard passenger engine of that period, which was a very light 10-wheel engine, by providing extra founts of oil on the running boards with pipes leading down to the driving boxes and eccentrics. This was at the time considered rather an extraordinary performance for a locomotive.

In the continuous development of the locomotive, however, provisions have been made for long runs and sustained efficiency by increased boiler capacity and improved machinery. Again, water treatment has become so general on the principal lines that boiler troubles resulting from running a locomotive from one district to another has been so materially lessened that in some instances waters which some years ago could not be successfully mixed are now so nearly uniform that no trouble is experienced from foaming and other similar causes in moving engines from one district or division to another.

The question of fuel has also had much to do with continuous runs. Locomotives supplied with poor coal, as many of them were, could not be successfully handled for a long period of time owing to the fact that it soon would become necessary to detach the engine from the train or hold the train on unusually long runs for roundhouse forces to clean the firebox of cinders, clinkers, etc., and this operation not infrequently resulted in causing the flues or other parts of the firebox to leak, but as a result of improved methods not only in constructing, but repairing fireboxes together with very liberal facilities for water treatment so as to remove its impurities, and with a more uniform grade of coal or, better still, oil fuel, extremely long runs are now being regularly made which some years ago would have been thought impossible.

Aside from a number of noted long runs recently reported at the American Railway Association meeting, the following is of special interest:

Remarkable Performances by M-K-T Locomotive and Others in Continuous Runs

Locomotive No. 411 of the Missouri-Kansas-Texas ran from St. Louis, Mo., to Austin, Texas, 975 miles, without being detached from its train, and made another run somewhat similar four days later, June 15, when it took a train of 14 passenger cars from St. Louis to Oklahoma City, 549 miles, on 5,420 gallons of oil. Part of the way there were 15 cars and the total number of car miles was 8,523, making the fuel consumption per car mile 0.63 gallons. The train was taken over the ascending grade between Franklin, Mo., and Sedalia with a helper. This trip, like the former one, was made without detaching the engine from the train.

The Atchison, Topeka & Santa Fe has no less than seven through locomotive runs over the three hundred miles in passenger service, which are of special interest because of the character of the country traversed and the large amount of transcontinental business handled.

On the Southern Pacific, where conditions are particularly favorable because oil is used as fuel, passenger locomotives are making continuous runs between Sparks, Nev., and Ogden, Utah, a distance of 536 miles, and between Oakland and Baflersfield, Calif., 312 miles. Other notable runs on this system are: Between New Orleans, La., and Houston, Texas, 362 miles; Houston to Del Rio, Texas, 378 miles; Houston to Denison, Texas, 338 miles, and San Antonio to Dallas, Texas, 331 miles.

The Great Northern Railway operates continuous runs over two different routes between St. Paul, Minn., and Minot, N. D., distances of 526 and 456 miles, respectively. A most remarkable run was made on the Great Northern in June, 1922, when locomotive No. 1717 ran through from St. Paul to Spokane, Wash, 1,456 miles.

The Union Pacific has been operating through trains without changing engines between Council Bluffs, Iowa and Cheyenne, Wyoming, 515 miles, and between Cheyenne and Ogden, Utah, 483 miles.

Louisiana Railway & Navigation Company, operating the first through train from New Orleans to McKinney, Texas, was hauled the entire distance of approximately 1,000 miles by locomotive number 94, a Baldwin tenwheeler built in 1914.

Railway and Locomotive Engineering

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Tunnel Air

The report, published in another column from the Bureau of Mines is a valuable addition to the suggestions made in connection with the dangers and inconveniences associated with contaminated tunnel air.

That the ordinary tunnel is a thing to be dreaded by the crew of a freight locomotive will be conceded by anyone who has had even a casual experience on a hard working locomotive, even though it be in a double track tunnel with ample clearances. While in small single track tunnels, on large locomotives hauling heavy trains and with little clearance, the cab becomes a miniature hell on earth.

The temperatures of 114 Fahr. found in these Union Pacific tunnels must often be greatly exceeded. It is not unusual to feel that the hot air is actually scorching the skin and the clothing burning into the flesh. As for the carbon monoxide present, it rarely affected the train crews seriously, though the casual rider is often overcome.

The usual and only protection against the gases is a large bunch of waste into which the face is buried. The heat and the difficulty of breathing through this impediment, often produces a feeling of suffocation, and the temptation to remove the waste from the nose and mouth to get more air is frequently yielded to by the novice with disastrous results. It would seem as though the conditions were beyond human endurance and that the time would never come when the engine would emerge from that atmosphere of smoke and darkness.

One of the earliest attempts to modify the conditions was made by the Norfolk & Western Ry. in the ventilation of the Elkhorn tunnel where conditions had become unendurable. The method used was designed by the then chief engineer of the road, Mr. Churchhill, and consisted of blowing a stream of fresh outside air through the tunnel in one direction. When the train is moving against the current of air the gases and smoke are swept back over and past the cab with sufficient rapidity to maintain good conditions. Then, when running with the current of air, the train is moved more slowly than that current, and the smoke and gases are blown on ahead of the locomotive and the men are supplied with an abundance of fresh air from the rear.

With such a system of ventilation the tunnel atmosphere varies so little from that on the outside, that there is no discomfort experienced even by a novice.

In November, 1920, RAILWAY AND LOCOMOTIVE ENGINEERING published a description of the methods used to mitigate tunnel conditions by the Southern Railway on the Cincinnati, New Orleans and Texas Division.

These methods consisted in the use of a simple deflecting hood that could be turned up over the top of the stack; the same thing supplemented by a conduit extending to the back of the cab, where the smoke and gas are discharged back of the crew, and of a fan taking air from a point near the ground beneath the cab and blowing it up on either side so as to keep the air fresh for the crew. All of these methods were efficient, especially the latter.

A fourth method that is used on this same road is the tunnel mask that was described in the March issue of RAILWAY AND LOCOMOTIVE ENGINEERING. This mask uses air from the main reservoir and is very efficient.

These facts can only be fully appreciated when the clearances between the locomotive and the tunnels on the line south from Cincinnati are considered. The tunnels are for a single track and were built when locomotives were much smaller than they are today, with the result that the present equipment so fills them that, when once in, it is impossible to get off from the locomotive on either side and the roof is only about 12 in. or 15 in. from the top of the stack.

The conditions in these tunnels are almost unendurable without the means of mitigation that are used, and with either the mask or the fan ventilation there is scarcely any discomfort.

There are many tunnels in which the crews experience only a moderate amount of discomfort, and this can be easily remedied. Of all remedies there are three which will insure fresh air: The Churchill method of tunnel ventilation; the drawing of air from near the ground and blowing it up into the cab, and the use of a mask taking air from the main reservoir.

When normal conditions and the ease with which they can be changed are considered there seems to be little excuse for suffering as the result of foul tunnel air.

Proposed Memorial to Phineas Davis

The Conservation Society of York County, at York, Pa., of which H. C. Ulmer is executive secretary, is making an effort to build a memorial to Phineas Davis, whose remains are in an unmarked grave in an old Quaker cemetery near the central part of the city of York. The old Quaker church was about to be removed and the burying ground occupied by a power plant. The society succeeded in forestalling this move and have purchased the church and hope later to be able to erect a suitable memorial and are asking railroad companies and engineering societies to co-operate with them.

Phineas Davis was born in Grafton, New Hampshire, in 1795. He became interested in the application of steam as a motive power while a partner of Morris J. Gardner in the York foundry and machine shop. He designed a locomotive in 1831 because of an offer of $4,000 by the Baltimore & Ohio Railroad Company for one of American manufacture. It successfully performed the condi tions of the test made on June 1, 1832, and was purchased by the company. Several other locomotives of the same type, but of improved construction and larger dimensions, were built by Davis & Gardner in 1832, and soon afterwards Mr. Davis took charge of the company's shops at Mount Clare station, Baltimore, and continued the manufacture of locomotives and cars at those shops until his death at the early age of forty years on September 27, 1835, as the result of the derailment of one of his engines on which he was riding.

33 Months' Earnings Average 3.89 Per Cent

A special report of the Bureau of Railway Economics just made public shows that the net operating income of the railroads of the United States in the 33-month period from September 1, 1920 (the date upon which the six months' guarantee period expired), to June 1, 1923, has been at the average annual rate of return of 3.89 per cent for the country as a whole on the tentative valuation of the railroads as fixed by the Interstate Commerce Commission for rate-making purposes.

For the last four months in 1920 it was 3.10 per cent; 3.33 per cent for the calendar year of 1921; 4.04 per cent for the calendar year of 1922, and 5.69 per cent for the first five months of 1923.

The first five months of 1923 show a 19.4 per cent increase in gross operating revenues and an 18.2 per cent increase in gross operating expenses. The 1923 improvement in earnings, therefore, depends upon the narrow margin of 1.2 per cent increase in revenues over expenses.

The average annual rate of return for the railroads in the Western district during the 33 months' period was 3.81 per cent, while for those in the Southern region it was 4 per cent. In the Eastern district it was 3.94 per cent.

The Problems of Railroad Management

The problems confronting the railroads are so many and varied that they cannot be touched upon even lightly at this time and place; but I am so strongly impressed with the importance of one general feature, that I feel impelled to ask your attention for one moment to its consideration.

We have reached a period in railroad development when we find it difficult to make material reductions in the cost of transportation; indeed, there are conditions present today that indicate a possible increase in cost, if I am right, it is the great question to be considered by those whose duty it is to procure a due measure of revenue for the railroads. Any student of the technical aspect of transportation cannot have failed to observe that, by force of circumstances, the factors that have contributed in the greatest degree to the reductions in cost, have been represented by the operations of the motive power department, and the hope of further important reductions must still rest with that department. It is because of my long watching of motive power operations, as carried on in this country, that I am constrained to say that where modern equipment has been introduced and the most advanced practices established, the margin for further reduction in cost is very narrow and the balance may be easily thrown to either side.

When, some thirty years ago, the first step was taken in the introduction of larger units, reductions in costs were made by leaps and bounds, and have continued, but in a decreasing ratio, down to recent times.

On the other hand, the public demand for greater luxury in travel, and for quicker movement of traffic and improved facilities of every kind, contribute to an increasing ratio of cost; whether this demand be just, or unjust, need not be here considered. It is enough for us to know that it means an actual increase in cost, and that with our margin for improvement, we cannot long continue to heed these demands, without in turn asking our patrons to share with us in meeting the increased cost of transportation.—*Theo. N. Ely.*

The Diesel Locomotive

To the Editor of RAILWAY & LOCOMOTIVE ENGINEERING:

I have read with much interest the articles that have recently appeared regarding the application of the Diesel engine to a locomotive, and after studying the various methods of making such an application the use of electrical transmission appears to be the most practical.

Dr. Rudolph Diesel gave up the idea of making a successful application of his engine to the locomotive, and others have also failed from time to time. However, engineers are still working hard, both in America and abroad, to overcome the many mechanical difficulties, and occasionally we read of something being done. For instance, where an order has been placed for a number of Diesel-engined locomotives in Berlin by the Russian Railway Commission for use in Russia, the locomotives to be delivered this summer. Also we note a new application of the Diesel engine to motor car service on the Swiss State Railways, known as the Sulzer Diesel electric. This sounds encouraging, and it seems probable that the application of the Diesel engine to small passenger carrying cars will prove a success eventually, but in heavy passenger and freight service it is quite another thing, for in order to apply the Diesel engine, or any other form of internal combustion motor to a locomotive in a practical sense, it must be capable of competing with our most modern super-heated steam locomotive, must haul an equal trainload, have a reasonable weight per unit of power, be able to start a train, be adapted to all existing railway facilities and to make an equal or greater speed, it must be economical in the use of fuel, be as simple and sturdy as possible, and above all be reliable.

From present indications, it will be some time before we will realize the successful application of the Diesel engine to the locomotive though rapid progress is and has been made. It is suggested that the Diesel engine, because of its high thermodynamic efficiency over any other prime mover, its fuel consumption being one sixth that of a steam locomotive, makes the proposition a highly attractive one for the generation of electricity, and it could probably be used, if correctly applied, as the motive power for an electric locomotive.

We know that the electric locomotive is complete within itself to meet existing railroad requirements and that we acknowledge its superiority over the steam locomotive in many ways. The advantage that electric power offers to the transportation industry in that it makes possible the accomplishment of results previously impossible. Hence let us continue to improve the electric locomotive and provide it with a cheaper source of power, a complete electric generating plant, direct-connected generators with Diesel engines.

When we stop to view the size of a heavy duty electric locomotive of say three thousand horse power and note the mechanical perfectness and detail necessary to fulfil a practical service, then visualize a power plant as complete to deliver the required energy to same, we immediately realize something of the difficulty to endeavor to design and build the two within each other, keeping within limits of a practical railroad locomotive. Yet, this is exactly what would have to be accomplished in getting out a real Diesel-engined locomotive capable to handle a tonnage equal to that of a steam locomotive on a competitive basis.

If it is conceded that electric transmission is the proper one, we would require a power plant substantially the same as any other power plant driven by Diesel engines with the exception of a degree of refinement necessary to fit in with the portable requirement to go with the locomotive. This type of plant would be taken care of by a regular plant engineer with about the same relation to the motorman as a fireman is to steam locomotive engineer. Instead of a coal pile and shovel, we furnish him a couple of Diesel-engine driven generator sets.

For the sake of comparison, let's suppose that we have one of the 180 ton electric locomotives of the 2-6-2 types, 650 volt, D. C. rated at 2016 H. P. capable of hauling 900 tons coupled to a power plant. The plant would necessarily be capable of putting out 2424 H. P. to meet the requirement. A power plant of this size is not necessarily large, neither so very heavy. It would not be as expensive as one would surmise offhand.

The necessary design of generators and control would naturally add to the cost, otherwise, same as any other stationary Diesel-engine driven power plant.

We suggest the main generators be D. C. 600 volt, separately excited, the exciting current being furnished by a separate dynamo mounted on an extension of the generator shaft, with accumulator battery to feed the field windings of the exciter. The circuit to be arranged between generators and the locomotive motors and control so that the generators and engines would, or could, be run at a constant speed, insuring easy starting of a train and full control and economy in fuel consumption.

As for dead weight let us make a comparison. The later types of steam locomotives carry 48,500 pounds on trailer, 24,500 on the front truck, 180,000 for the tender—a total dead weight of 250,000 pounds. We would naturally subtract this from the weight of the power plant in making a reasonable comparison as between this class of equipment and that of the steam locomotive of equal power.

These plants would be constructed in units of two to three thousand H. P. each more or less, as the case may require. Two or more plants could be coupled together to the extent of any number of H. P. required to accommodate the largest locomotives, especially in case of double heading two or more locomotives to a train, the power plants being arranged between the locomotives making a very powerful motive power combination.

Again, with this type of electrification the generators and engines would be in operation only and when actually engaged in hauling a train, available at any point in just the required number of H. P. over the entire system.

It places the electric locomotive in an independent position, when coupled to the power plant, to go anywhere that a steam locomotive could go, hauling a train any distance from one end of the line to the other, available 24 hours in the day. Under the control of the operator, as great a tractive effort as the length of the cars would permit, at any speed considered safe and as a whole relatively cheap to maintain. The freedom from the necessity for stopping for coal and water a great advantage on busy tracks, particularly where heavy trains are operated with more than one engine per train. The absence of boilers to wash and fires to clean makes through runs over two or more divisions possible, the higher speed with this class of electrification and motive power increases the possible length of operating districts and would eliminate intermediate terminals, opening up an opportunity to transform a necessary service from a burden to a source of added income.

These considerations lead to a belief that a worthy competitor of the steam locomotive can be worked out along the individual unit basis, employing the Diesel engine portable plant.

Present terminal and shop facilities being adequate to take care of the maintenance of this class of motive power, without the further expenditures of large sums required to enlarge shops and to purchase new equipment, now necessary to take care of the modern steam locomotive, would probably cause a decided labor reduction at terminals, and do away with a number of division shops because of the continuous service rendered. In short affording every advantage of the present electrified system, together with the added advantage of cheaply electrifying of highly desirable sections of railroads.

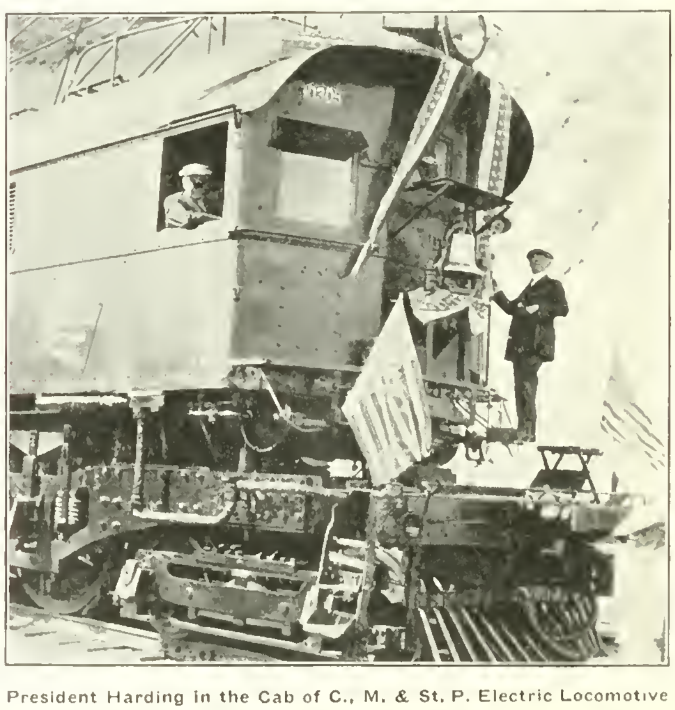
W. BLACKWOOD, M. E.

Long Beach, Calif

President Harding at the Throttle

Not all of us realize our boyhood ambitions. Fewer still are those who become President in the meantime. For about half an hour President Harding realized his boyhood ambition to become a locomotive engineer when he operated not the snorting steam locomotive but a gigantic Baldwin-Westinghouse locomotive of the Chicago, Milwaukee & St. Paul Railway.

At Sappington, Montana, the Presidential Special was transferred from the Northern Pacific to the Chicago, Milwaukee & St. Paul for the balance of the trip to Spokane. The President showed great interest in his stalwart steed and was invited into the cab. From Falcon, Idaho, down the slope of the Bitter Root mountains, around sharp curves, through tunnels and along canyon sides the Chief Executive guided the heavy 12-car train until it reached Avery, a total distance of 15 miles. This big electric locomotive equipped by the Westinghouse Electric & Manufacturing Company is one of ten 4200 hp. giants operating in regular passenger service drawing the famous "Olympian" and "Columbian" trains over the steep grades of the Cascade, Belt and Bitter Root Mountains.



President Harding in the Cab of C., M. & St. P. Electric Locomotive

Railway Shop Kinks

Devices for Testing Air Brakes—A Flue Swedging Machine

The group of devices shown herewith are used for testing the condition of the air and steam lines, brake cylinders and compressors.

Fig. 1 is used for testing the steam heating gauge, the reducing valve and the hose on the rear of the tender. It consists of the regular steam hose coupling *A* into which a 1½ in. nipple (*C*) 4½ in. long is screwed for a handle. This nipple is closed with a regular pipe cap. The top of the coupling is drlled and tapped for a 3½ in. test gauge *B* and on the side for a pet cock that is used as a vent to blow out the water of condensation and steam. There is also a small chain attached by which it can be hung up while it is hot and in use.

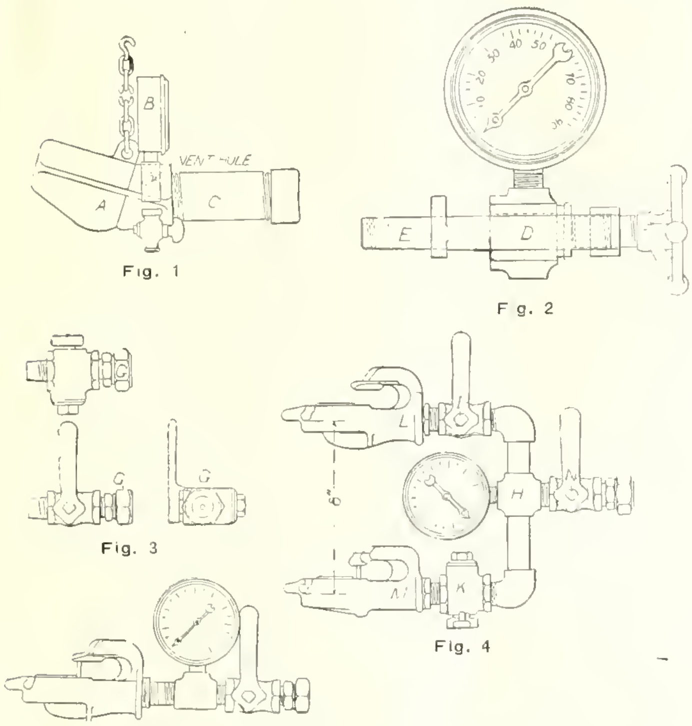


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5

Devices for Testing Air Brake Equipment

In application, this device is attached to the hose coupling at the rear of the tender and is hung up. Steam is then turned into the reducing valve and the pet cock opened until the water of condensation has all blown out. The pet cock is then closed and the test gauge on the device used to check the pressure registered on the steam heating gauge in the cab and the reduction of pressure by the reducing valve. At the end of the test the steam is shut off on the engine, the pet cock opened to blow out the steam contained in the piping and the device disconnected.

Fig. 2 is a device for testing air brake cylinders. It consists of a fitting *D* with a nipple *E* on one side, that can be screwed into the side of the cylinder. A small test gauge is screwed into the top of the fitting, and on the side opposite the nipple *E* there is another nipple upon which a hand wheel *F* is screwed. This last is used as a handle and as a means of screwing the device into a tapped hole in the cylinder.

The method of using the device is quite obvious. After it has been screwed into place, a brake applicaton is made. The pressure developed is registered by the gauge and the rate of leakage can be noted by the dropping back of the pointer.

Fig. 3 is a device for making a test of the capacity of an air compressor. It is made of a 1½ in. plug or drain cock. One opening has a threaded teat for screwing into the main reservoir or pipe and the teat on the other side has a reducer and cap *G* containing a choke fitting for making a capacity test of the air compressor.

The diameter of the hole in the choke fitting is 11/16 in. or 3/16 in. in order to determine whether the pump can meet the requirement of being able to maintain a pressure of 60 lb. per sq. in. against a leakage through a hole of 11/64 in. or 3/16 in. in diameter.

In application the device is screwed into a pipe connection to the main reservoir the pressure pumped up to the required amount of lbs. per sq. in., when the plug valve is opened and the leakage allowed to take place through the choke opening.

Fig. 4 is a duplex arrangement for making a test of the air brake and signal lines on passenger trains. The base of the device is a ¾ in. pipe cross *H*. Into opposite sides of this nipples are screwed which lead to reducing elbows to which the ½ in. drain cocks *I* and *K* are screwed respectively. To these the air hose coupling (*L*) and the single hose coupling *M* are screwed respectively. The nipples are of such length that the distance from center to center of the two couplings is 8 in.

The other two sides of the cross are connected to a pressure gauge and a drain cock *N* as shown. The drain cock on its free side is fitted with a choke disc and opening similar to that described in connection with Fig. 4.

In application the two couplings *L* and *M* are connected to the air and signal hose couplings respectively and the cock *N* is closed. When the air brake line is to be tested the cock *K* is closed and the cock *I* opened. Any pressure in the air brake pipe line will, then, be registered by the gauge and the rate of fall of pressure or leakage can be noted.

Then the cock *I* is closed and the cock *K* opened for the testing of the signal line, when similar observations can be made.

In case an artificial leakage of either line is to be set up, the cock *I* or *K* leading to it is opened as well as the cock *N* when the rate of leakage will be determined by the diameter of the choke opening already referred to.

Fig. 5 shows a device for testing the air brakepipe lines on freight engines. It is similar in every respect and is used in the same way as Fig. 4, except that it carries only one connection which is for the brakepipe, as the air signal is not in use.

FLUE SWEDGING MACHINE

This flue swedging machine is one that has been designed and built for use in the Richmond, Va., shops of the Chesapeake & Ohio Ry. Again the discarded air brake cylinder comes into its own for a second period of usefulness. The frame of the machine is of wood, with a bed made of two pieces of 2 in. by 7 in. stuff carried on legs made of 4½ in. by 3 in. timber. The total length of the frame is 23 ft. 4½ in. At one end an 8 in. by 12 in. air brake cylinder is bolted, which is arranged for an admission of compressed air through the back head. The front head has the usual retracting spring. The end of the piston rod carries a stud to which a plunger block *A* is screwed for pushing against the end of the tube.

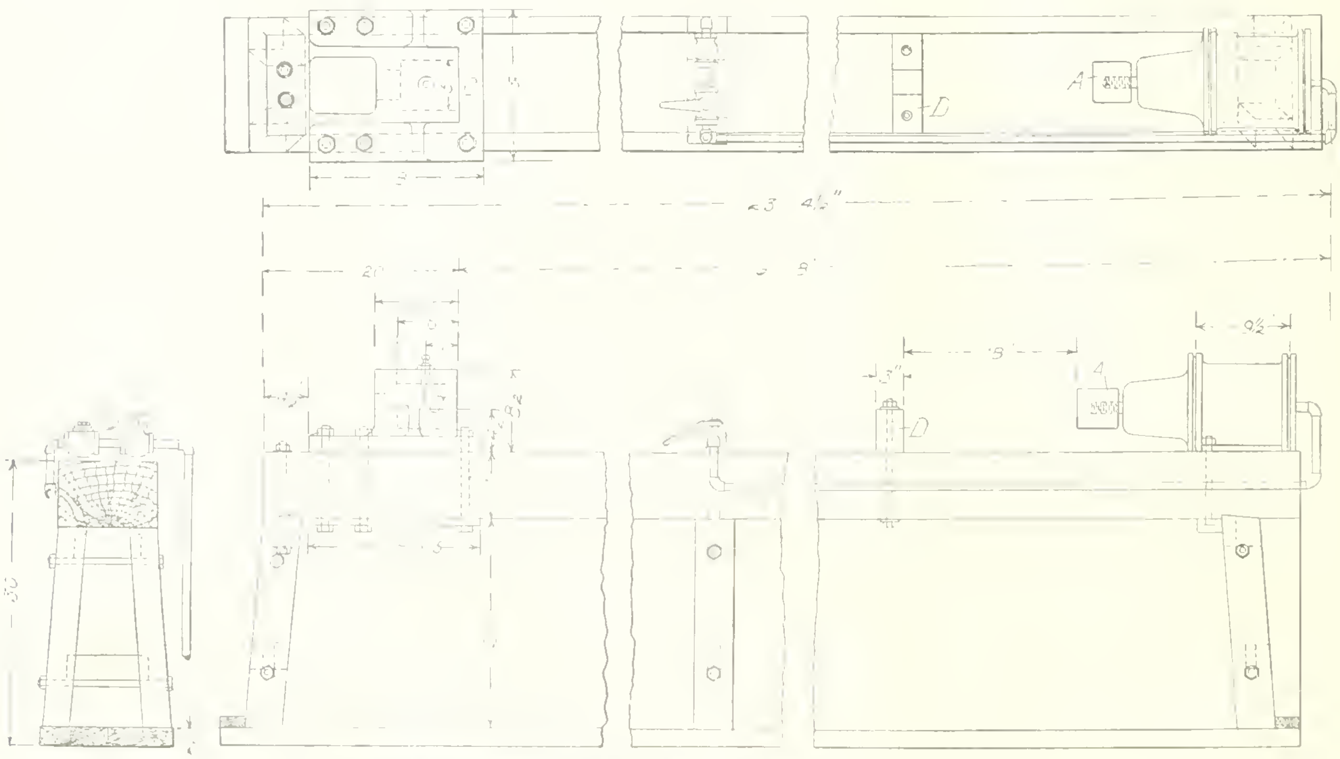
At the other end of the frame a heavy casting C is bolted. This is bored out at the side facing the working cylinder to a diameter of 5 in. and a depth of 6 in. as indicated by the drawing. This hole serves for the reception of the swedge blocks which are turned to an easy fit and bored to the desired taper for the tube, and are still held in place by a ¾ in. set-screw.

The three way cock for operating the working piston is placed about midway of the length of the frame. Air from the shop system is admitted to and exhausted from the cylinder by means of this valve. The cross tie of the frames *D* have a grooved cut in its upper face so that, when a tube is laid in it, the tube is brought central with the plunger on the piston.

Valves, Valve Gears and Power Reserve Gears, F. J. Spanganberger, chairman; topic No. 3, General Repair Methods and Maintenance of Stokers, Coal Pushers and Air Fire Doors, W. S. Buntain, chairman; topic No. 4, Shop Kinks, Locomotive and Car Departments, G. H. Logan, chairman; topic No. 5, Welding of Tires, Flanges, etc., H. T. Cromwell, chairman.

Mayor Dever of Chicago will deliver an address of welcome. The meetings will be presided over by J. B. White, president of the association.

Extensive exhibits are planned for this meeting. Application blanks and particulars can be secured by applying to the secretary, William Hall, Wabash Street, Winona, Minn.



Details of Flue Swedging Machine of the Chesapeake & Ohio Railway

The method of operation is quite obvious. The tube is laid in the groove of the cross tie *D* and butted against the plunger head *A*. The other end, which has been heated is set opposite the hole in the swedge block. The compressed air is then turned into the cylinder and the hot end of the tube forced into the swedge block. With the exhausting of the air the finished tube can be removed. The speed of operation depends upon the ability of the operator to handle the tubes in and out of the machine.

General Foremen's Convention

The International Railway General Foremen's Association will hold its annual convention at Hotel Sherman, Chicago, September 4, 5, 6 and 7. The convention will be addressed by Ben W. Hooper, Chairman U. S. Railroad Labor Board; James C. Davis, Director General of Railroads; H. T. Cromwell, Baltimore & Ohio Railroad and L. A. North, Illinois Central Railroad. Reports on the following topics are to be read and discussed: topic No. 1, Shop Efficiency in Locomotive and Car Department, A. F. Villeam and Charles F. Barmen, Chairmen; topic No. 2, General Repair Methods and Maintenance of

I. C. C. Report Shows Costs of Equipment

A decision of the Interstate Commerce Commission granting the Philadelphia & Reading Railroad Co. authority to purchase new equipment shows the current costs of railway rolling stock. The Commission's decision permits the Reading Co. to sell $6,000,000 of equipment trust certificates, from the sale of which $7,003,783.36 worth of equipment is to be bought. The equipment specified and the prices were as follows:

		Unit Price.
500	70-ton steel hopper coal cars	$2,072.45
[illegible]	70-ton steel hopper coal cars	2,135.37
[illegible]	70 ton steel hopper coal cars	2,067.82
500	70 ton steel hopper coal cars	2,075.58
15	Steel passenger coaches	18,710.62
30	Steel passenger coaches	18,723.19
45	Steel passenger coaches, suburban type	17,189.97
5	Steel combination passenger and baggage cars	17,550.97
[illegible]	Steel combination passenger and baggage cars, suburban type	16,702.12
[illegible]	Steel baggage cars	17,241.68
2[illegible]	Consolidation locomotives	38,192.00

Origin and Development of Freight and Passenger Cars

By E. F. Carry, President, The Pullman Company

Individual Paper to the Mechanical Division Meeting of the A.R.A.

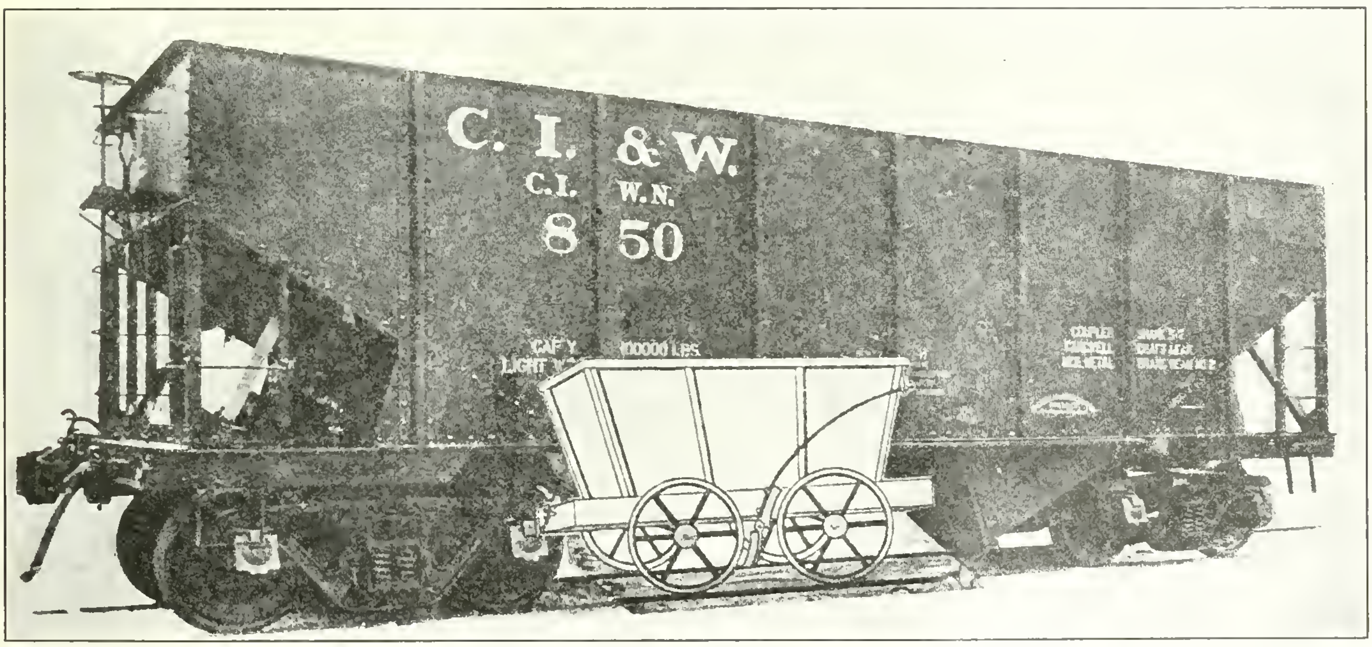
In reviewing the evolution of railway carriages it may be of interest to sketch very hastily the development of transportation from its inception to the present where it has found its highest expression in American railways.

As civilization obviously has progressed in exact proportion to the development of transportation it is seemingly a corollary that the origin of transportation marked the inception of civilization. Transportation was not only the advance agent of civilization but also furnished the key-stone around which its very arch was constructed.

Without transportation facilities the farmer today would be marooned on his acres; he would be a localized industry. He would be dependent entirely upon what his soil produced; he would be without a market for his products; he would be clothed in homespun and in skins. With the farmer isolated there could be no great communities, no manufacturing centers, no hives of industry, no factories. If some great calamity should destroy railroad connection with any large city, that city in 48 hours would feel the pangs of hunger and inside of a week its inhabitants would either have to seek food elsewhere or die in the streets. Without transportation diet would be restricted. Bread would be a drug in the wheat states and practically unobtainable where wheat does not grow. Meat eaters would have to move to where cattle range; babies in great cities would die from lack of milk. The great fruit orchards and vegetable farms of the South and West which through the aid of the refrigerator car are enabled to supply the tables of the North and East with their products, would go out of business. Ore would stay in the earth where nature placed it; coal would remain unmined; the cotton plantations of the South would revert to the weed patches and the sheep of the West would remain unshorn. In fact life would hardly be worth living if we had to rely on the means of locomotion and carriage provided by nature.

Land transportation had its origin in the pre-historic age and in man's primordial state woman was the burden carrier, as she is today among the savage races of the world, and to make this human carrier more efficient trails were created through forests and across plains. These trails marked the course of the future highways of civilization. The primitive transportation magnate was the man with the greatest number of wives and polygamy was therefore one of the early forms of concentrating capital. Just when primitive man transferred the burden from the shoulders of a woman to the back of an animal is a matter of conjecture but the transfer was final and the first step in solving the problem of land carriage was directly traceable to that occurrence. The first mechanical carriage was a roughly hewn plank drawn by an animal; the plank was transformed into a sledge; then came rollers, wheels and cart and, finally, the four-wheeled vehicles which necessitated the creation of highways in place of the crude paths that had been in use.

Animal-drawn vehicles served the purposes of land transportation until the seventeenth century when the necessity for increasing capacity led to the adoption of wooden rails at the collieries of England for the conveyance of coal to the river or the sea. This marked the inception of tramways or colliery roads, and from the seed thus planted came the railroad. The vehicles used on these first colliery roads were bulky carts made with four rowlets fitting the wooden rails and were in effect nothing more than boxes mounted upon rollers. They had a capacity of about one ton of coal each and were horse-drawn or propelled by gravity. The development of the freight car from the first colliery "wagons" progressed slowly as for many years their use for any purpose other than the hauling of coal was not considered, and their propulsion by horse-power or gravity necessarily restricted increase in size and capacity. The suc-



Coal Car of 1830 Compared with a Coal Car of Today cessful application of steam for motive power during the second decade of the nineteenth century, however, marked the emancipation of railroads from dependence upon animal power, and furnished the impulse for the inauguration and growth of the railway systems of the world. With the introduction of the steam locomotive, passenger cars came generally into use, and it is difficult from this period forward to trace separately the progressive improvements in the development of freight and passenger cars, as most of the mechanical features were developed concurrently on both classes of equipment.

Freight Car Development

In outlining the evolution of the freight car, the pioneer of railroad equipment (and our railroads' greatest revenue producer) we encounter a woeful lack of records of the long series of advances made in capacity, size and variety of cars, a circumstance possibly due to the lack of romance in association with the progression of this most useful but prosaic type of car. The history of the freight car has never been written. Aside from the colliery cars, the first cars devoted to the handling of miscellaneous freight in England consisted simply of a bed or platform upon which the goods were stacked and covered with a tarpaulin and also a gondola type with slatted sides and ends. This open car, the forerunner of our modern flat car, answers general traffic requirements in foreign lands even to this day as distances are short, freight is dispatched with great celerity and is usually loaded and unloaded the same day. The prevalence of steep grades and sharp curves on the early railroads of this country, as distinguished from conditions in England necessitated a different form of development for both passenger and freight cars in the United States; furthermore, the greater distances in this country, coupled with the greater volume and diversity of traffic necessitating distribution over vast areas, required the building of larger and varied types of freight cars. Prior to 1870, the history of freight car construction in this country is vague and obscure. The cars used on the early lines in America were not only of the lightest possible construction but also of the greatest diversity of shape and design. The "burden cars," as freight cars were then called, were really nothing more than boxes a little longer than their width with four wheels and a capacity of three or four tons. On the Mauch Chunk, one of the earliest coal roads, each car had a dead-weight of 1,600 lb. and a capacity of 3,200 lb., the ratio of dead-weight to carrying capacity thus being as 1 to 2. On the Little Schuylkill, another early coal road in Pennsylvania, the cars were built to carry three tons of coal and were equipped with wheels three feet in diameter, two of which were loose on the axles in order to lessen friction on the curves. With a rapidly growing population and a gradual widening in areas of distribution, however, the constantly increasing traffic demands upon the early railroads necessitated an increase in the number of the small capacity cars, but the addition of these extra units to the train so increased length as to render it unwieldy and difficult to handle.

The necessity for an increase in the unit capacity of freight cars became apparent and the introduction of four-wheeled trucks not only rendered this possible but, also, marked the first step in the evolution of distinctively American types of freight cars.

Prior to 1870, however, freight cars were still of limited capacity as an average load of nine tons per eight-wheeled car and four tons per four-wheeled car was considered heavy loading. The eight-wheeled cars in use on one road were 28 ft. to 33 ft. in length, had an average dead-weight of 16,000 pounds and a loading capacity of 18,000 pounds, the ratio of dead-weight to carrying capacity thus being 1 to 1⅛. Up to 1876 the average capacity of freight cars remained at 20,000 pounds although it was customary to load in excess of that figure. In 1877 some cars were built to carry 30,000 pounds and beginning in 1879 the standard cars built for the principal lines were constructed to carry 40,000 pounds.

The comparative weight of a standard Pennsylvania Railroad box car, with its load, in 1870 and 1881 was as follows:

Year	Weight of Car	Weight of Load	Total	Load to Total Weight	Ratio of Dead-weight to Carrying Capacity
1870	20,500	20,000	40,500	49.38%	1 to 1
1881	22,000	40,000	62,000	64.52%	1 to 1.8

This shows considerable progress was being made in the matter of increasing the carrying capacity of freight cars with little, if any, increase in the dead-weight. Notwithstanding the gain of 30 per cent in the ratio of paying weight to gross weight the ratio of dead-weight to paying load was 1 to 1.8, indicating the difficulty which the roads were experiencing at that period in obtaining the ratio of 1 to 3 which Jonathan Knight, civil engineer of the B. & O. Railroad, as early as 1832 submitted as the most economical.

As contrasted with the situation forty years ago, the following table, showing for certain types of modern freight cars the ratio of dead-weight to carrying capacity, will indicate the remarkable progress made by the railroads and the car builders in designing cars that give an economical ratio between the weight and load:

	Weight of car	Load	Total	Load total wt.	Ratio of dead-weight to carrying capacity
1919 USRR adm. single sh. box.	46,900	110,000	156,900	70%	1 to 2.35
1919 USRR adm. double hopper.	41,000	120,000	161,000	74%	1 to 2.93
1919 USRR adm. gondola......	43,100	110,000	153,100	72%	1 to 2.55
1921 Virginian coal car........	78,900	240,000	318,000	75%	1 to 3

This indicates that the predicted ratio of 1 to 3 has been attained for certain types of coal cars and in the case of an experimental ore car a ratio of 1 to 4 was reached. The economies to the railroads and to the public resulting from these developments are obvious.

Developments of Particular Importance

The year 1867 was a vital one in the annals of American railway car building. The pioneers of you gentlemen assembled here today met and formed "The Master Car Builders' Association," and on Washington's Birthday of that same year there appeared on the transportation stage a young man, who was destined to become one of the world's greatest master car builders, a man whose vision and genius enabled him to surmount what had seemed insuperable obstacles; a man who foresaw the possibilities of giving to the American public comfort and luxury in travel—George Mortimer Pullman. He was a pioneer, the creator of a new business. In the same period there came another advancement of great significance—the invention of the Westinghouse air-brake, and its successful application in the winter of 1868-1869 to eight cars and an engine on the Steubenville accommodation train on the Pittsburgh, Cincinnati and St. Louis R. R.

The organization of the Master Car Builders' Association marks what was virtually the first step in the standardization of interchange parts of American cars. The work accomplished by the Association in this respect has been and will continue to be of incalculable value to railroad operation. In its "Standards" and "Recommended Practices" the Association has created a monument appropriate to the purposes of its organization, viz: "the formation and dissemination of correct views regarding car construction." To the railroad officials of which the Association was composed we are indebted for the progress in railroad equipment.

Some idea of what the M. C. B. has accomplished in the way of standardization of car parts may be observed from the following list which summarizes the achievement up to the present time:

Journal boxes—58 kinds reduced to 5 sizes, one interchangeable type.

Axles—56 kinds reduced to five sizes, one interchangeable type.

Couplers—26 kinds reduced to 1.

Brake Shoes—20 kinds reduced to 1.

Brake Heads—27 kinds reduced to 1 interchangeable standard.

Wheels at present, three types—4 sizes.

Brake Beams at present—all interchangeable.

Grab-irons fixed by law.

Draft gear—standards being prepared by Mechanical Division, A. R. A.

The Westinghouse air brake opened the way for the safe handling of trains of increased length and cars of higher capacity. Its value to operation was demonstrated in 1887 by a test on 50 freight cars (a train of 1,900 feet and a weight of 1,700,000 pounds) which was brought to a stop from a speed of 20 miles an hour in a distance of 171 feet. To stop the same train at the same speed by the use of hand brakes by 5 men, all ready for simultaneous action, required a distance of 1,563 feet.

Miscellaneous Developments

In 1857 an Eastern railroad had 30 box cars fitted with double sides, roofs, floors and the interstices packed with sawdust. This in its crude form was probably the first refrigerator car. In 1871 there was introduced a refrigerator car equipped with ice bins, or compartments, at the ends of the car and about 1881 the first stock car with watering troughs and feed bins was constructed.

The introduction of the automatic coupler, extending over a period from 1883 to 1888, tested by the Pennsylvania R. R. in 1883 and 100 sets tested by the C. B. & Q. R. R. in 1884, marked another great forward step in the safe and prompt handling of freight equipment, obviating the need of a man between cars in coupling.

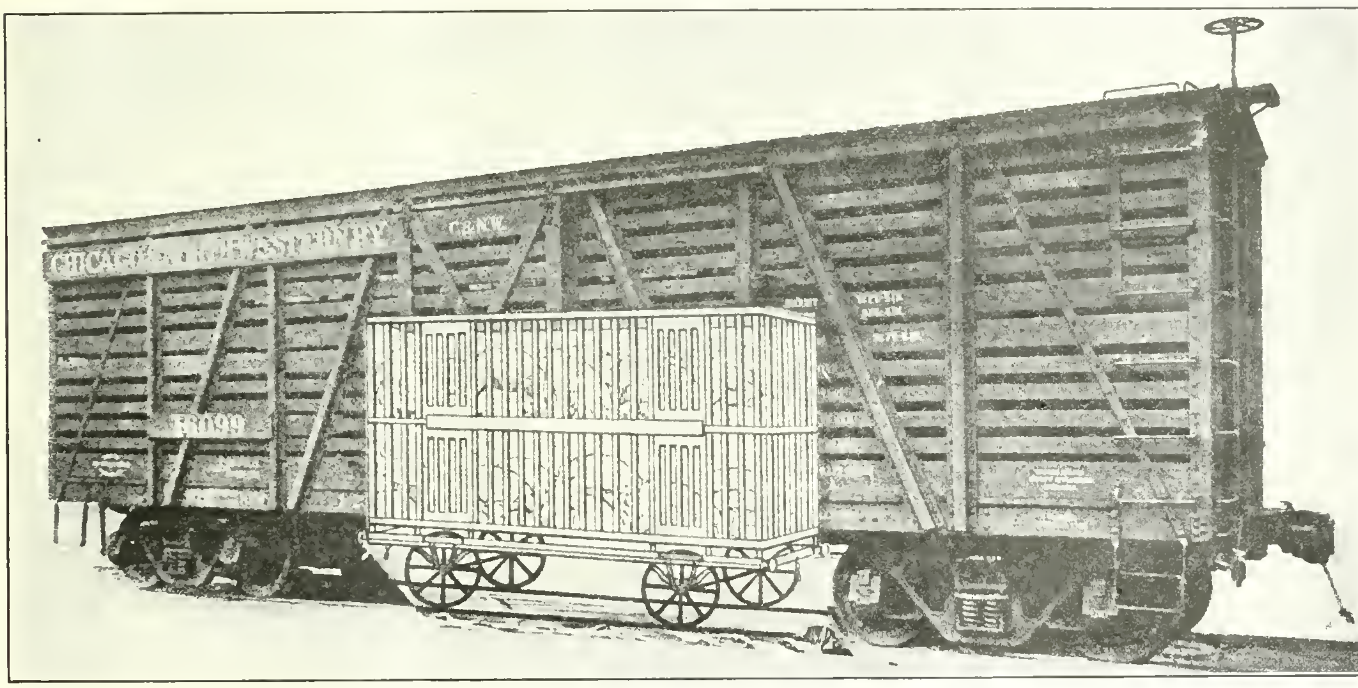
With the advent of the air brake and the automatic coupler, permitting high speed and quick handling of heavy equipment, the inadequacy of the wood frame car became apparent, a situation met by and resulting in a complete revolutionizing of the car building industry by the change from wood to steel cars.

Wooden draft timbers bolted to the bottom of wooden center sills pulling out, wooden center sill breaking at bolsters and the difficulty in obtaining an adequate supply of timbers for the gradually increasing sizes of cars, made a change to stronger and more readily obtainable materials imperative. Thus, born of necessity, came draft sill reinforcements of steel, steel underframes for wood cars, steel frame cars and all steel cars.

Development of Steel Freight Cars

The use of steel in car construction probably was first introduced in 1874 in the form of channel iron for sills and bolsters in a car operated in stock service on an Eastern line. In the late seventies or early eighties a peculiarly shaped iron body hopper car, known from its shape as a three-pit hopper, was introduced which was of 13 ton capacity, weighing 12,800 lb. Southern Iron Car Line in about 1882 introduced what was known as the pipe car, the center and side sills of which were of truss type, pipes acting as top and bottom members held apart by separating clamps. End sills were of malleable iron and later trussed iron bars, bolsters were of angle iron. This type of car proved unsatisfactory in service.

It was not until 1894 that the modern steel car became a recognized unit of American railway service. In that year the Carnegie Steel Company had 6 flat cars built, and in 1896 the Keystone Bridge Company built two 100,000 lb. capacity steel hopper cars which were exhibited at a convention at Saratoga and afterward placed in service on the Pittsburgh, Bessemer & Lake Erie R. R. This railroad in 1897 placed the first large contract for building steel cars in this country when 1,000 cars were built, 600



Early English Stock Car Compared with a Modern American Type of pressed steel and .00 of rolled structural shapes.

From that period forward, progress in the construction of steel freight cars has been rapid, as indicated by the following comparison of cars in service on Class I R. R. as of December 31, 1921:

Total Number of Cars in Service	2,378,682
Steel Freight Cars in Service	640,891
Proportion of Steel Cars	27%
Steel Underframe Cars in Service	903,240
Aggregate Number of Steel and Steel Underframe Cars	1,544,130
Proportion of Steel and Steel Underframe Cars to Total	65%

One of the most remarkable features in connection with freight car development has been the rapid increase in the number and carrying capacity of freight cars as well as the extent to which maximum utilization of the increased capacity has been secured. The following tabulation shows the number, capacity and average loading of freight cars during 1921 as contrasted with 1902, the earliest year for which reliable data are available regarding capacity of all freight cars in service, and presents a striking picture of the advance made during that 19-year period:

Freight Equipment in Service for Comparative Periods

	Number of Cars	Aggregate Capacity (Tons)	Av. Capacity per Car (Tons)	Av. Net Tons Loaded per Car
1902	1,546,101	43,445,438	28.1	16.92
1921	2,378,682	101,093,985	42.5	29.30
Percent Increase 1921	53.9%	132.7%	51.2%	73.4%

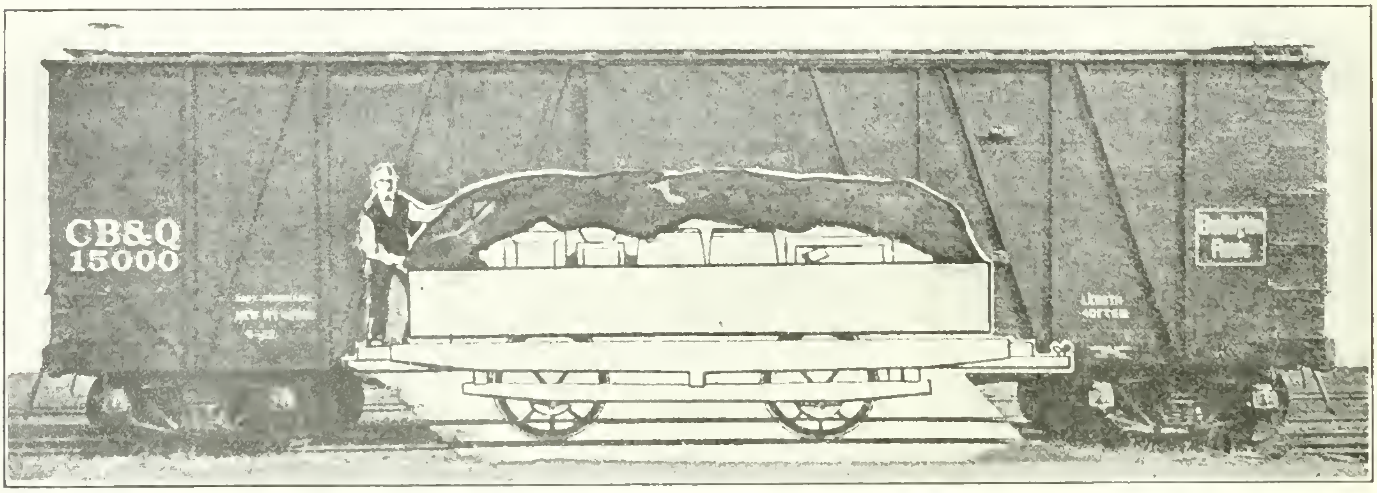
Notwithstanding the remarkable expansion reflected above in the number of freight cars it will be noted that their aggregate carrying capacity has increased at a rate nearly two and one-half times faster than the increase in units.

Development of Passenger Cars

The introduction of the bogie truck by Ross Winans on a B. & O. passenger car about 1831 ushered in the first eight-wheeled car, and marked the beginning of the radical difference that quickly developed in the type of construction as between the English and American cars. The ability of this eight-wheeled car to round the curves which abounded on most of the railroads led to its general adoption by the progressive lines about 1835.

Of an eight-wheeled passenger coach built in 1840 the historian stated that it was devoid of springs aside from the ordinary rubbers in the pedestals; the only ventilation was secured by means of a 10-inch flue in the center of the car; the windows did not raise but the panels between them could be lifted instead; there were no lighting arrangements unless a candle placed at each end of the car could be so classified; heat was supplied by one stove; there were no closets, lavatories, or water coolers; the wheels were outside of the bearings on the original trucks; the seat frames were of iron with walnut arms and upholstering of plain leather; and the body of the car was 36 feet in length, 8 feet, 4 inches in width and 6 feet, 4 inches in height. In its arrangements, structural features, appliances, etc., this car was doubtless typical of the passenger coaches in service on the principal lines during the period 1840-1850, and while the arrangements of this car indicated that marked progress had been made in passenger car construction it was conspicuously lacking in a number of modern improvements.

From 1860 to 1870 the passenger cars in general use had seating capacity for about sixty passengers and a body about fifty feet long, ten feet wide and seven feet high; seats were cushioned and heat was furnished by stoves and light by oil lamps. These cars were equipped with rubber and elliptic springs, the metal for axle bearings was in process of experimentation, hand brakes were still in use and attempts were being made to devise a reclining seat.



Early English Goods Wagon Compared with a Modern American Box Car

During the seventh decade passenger car development seemed to attract particular attention as this was the period in which the use of sleeping cars on through lines first became effective and dining and parlor cars made their initial appearance.

The influence of the Pullman car has seemingly been a most potent factor in the development of passenger carrying equipment. As the Pullman Company was the originator of de luxe sleeping car service, so also it was the initiator of complete hotel service as applied to trains. In 1867 it introduced the hotel car "President," a sleeping car with a kitchen at one end, and this was the forerunner of the dining car which was a later development by the Company and which supplanted the hotel car. In the words of a contemporary historian, these Pullman inventions at one bound "placed the American railway passenger service in the forefront of all nations."

As regards mechanical and structural features, passenger car development proceeded very closely along the lines followed in the evolution of the freight car. The original wood frame passenger cars were improved by increases in size and carrying capacity so far as was consistent with safety in connection with wood construction. Next came the composite steel construction and there was finally evolved the all-steel passenger car and the gradual transition from wood to steel construction assumed such proportion that there was virtually created a new industry in connection with car building, viz., the production of steel cabinet work for the interior finish of the car. The first all-steel passenger car turned out by the Pullman Company was built in 1908, although the Pennsylvania Railroad had acquired some steel cars at an earlier date.

With the arrival of the steel age it is of interest to note the evolution that occurred in interior decoration. From the wood interior of the early cars which were entirely devoid of any attempt at embellishment or decoration there came the era of highly ornate and over-decorative style with inlays, heavy carvings, and other decorative embellishment which was followed by gradual reversion to plainer styles with less panel work and ornamentation and, finally, there was adopted the plain, sanitary and modern steel finish of today with a minimum of decorative features.

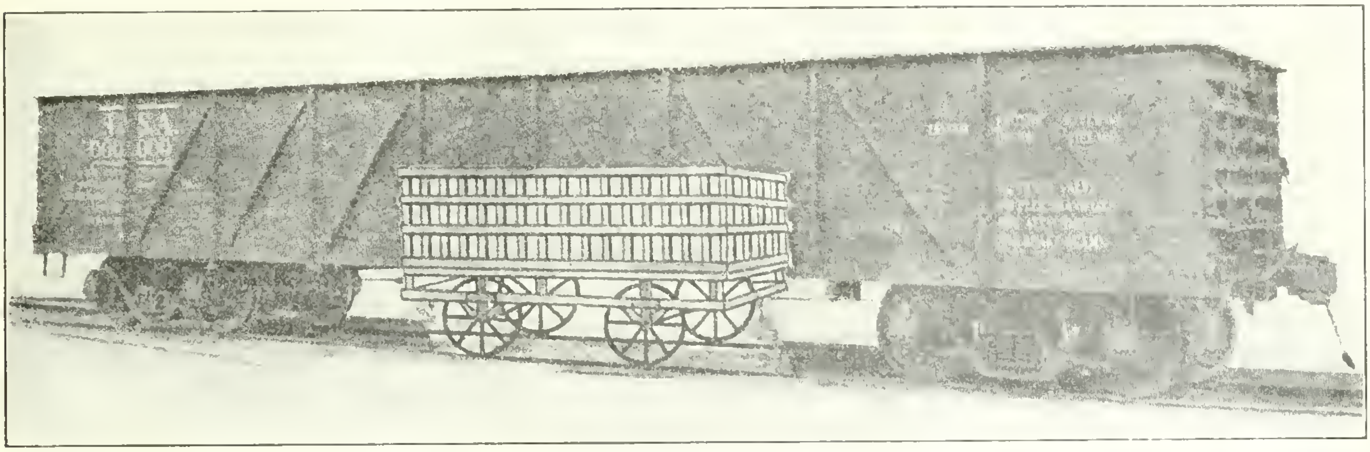
In the arrangements and improvements of passenger cars the Master Car Builders have invented innumerable devices and appliances intended to promote the safety, comfort and convenience of the passenger with particular attention devoted to increasing the strength of the car.

The criticism has been made that the passenger coach of today differs but little from the coach of twenty-five years ago, but a comparison of a typical coach of 1898 period with one built in 1922 will readily disclose the radical differences between both cars.

Passenger Coaches—Today and Twenty-Five Years Ago

	Vintage of 1898	1923 Model
Length....	48 ft. 6 in.	70 feet
Weight....	53,000 lbs.	140,400 lbs.
Capacity....	56 passengers	84 passengers
Construction..	Wood	Steel
Wheels per truck.	4	6
Platform.........	Open	Vestibuled
Lighting.......	Oil lamps	Electricity
Heating	(Stove in one end with coal box)	Steam

Modern American passenger equipment has been subjected to criticism as being too heavy. Safety is the first consideration in the minds of every master car builder and high speed has made it necessary to so construct cars that their various parts must be heavy enough to provide an ample margin of safety and strength, not only to resist



Early English Gondola Compared with a Modern American Type

the sudden shocks and distortion stresses on the structure which use imposes, but also to give ample provision against deterioration and reduce the cost of maintenance to a minimum. Light cars have proved unequal to the requirements of American passenger travel. The weight of modern passenger equipment is the result of service demands—the safety and comfort of passengers—and these requirements are its adequate defense.

Every effort has been made by the car builders to perfect methods of heating, lighting and ventilating cars, to improving the seating arrangements, platforms, couplings, lavatories, miscellaneous furnishings, interior finish, etc., one of the most notable advances having been the development of the vestibuled train which permits safe and convenient passage from one car to another.

Contrasted with the original crude passenger car, there are now many and varied types of cars devoted exclusively to the transportation of passengers, these types including Sleepers, Parlor, Lounge, Club, Observation and Library Cars, Coaches, Chair Cars, Smoking Cars, etc. The other general sub-divisions of passenger train cars include baggage, mail, express, and milk.

The light wooden passenger cars are being rapidly displaced by the all-steel and steel underframe car, and the extent to which these types are superseding the wooden car in passenger service is disclosed by contrasting the classified passenger car ownership as of January 1, 1922, with the ownership as of January 1, 1911, as follows:

	1911	1922	Increase Number	Increase Percent
Wood cars in service, including Pullmans	53,274	33,433	*19,841	*37%
Steel underframe cars in service, including Pullmans..	1,636	9,505	7,869	481%
Steel cars in service, including Pullmans	3,589	20,569	16,980	473%
	60,499	63,507	3,008	5%

*Decrease

When consideration is given to the fact that the modern passenger car is equipped with electric lighting and steam heating systems, toilet and wash-room facilities supplied with running hot and cold waters, coolers for drinking water, drinking cup vendors, electric fans, plush upholstered seats with headroll and automatic foot rest, continuous parcel racks in body on each side of car, window shades, windows that can be raised and lowered, exhaust ventilators in deck sash in body of car and in men's and women's saloons, an interior finish of mahogany color, etc., it will be seen that the all-steel passenger coach in its present stage of development embodies the maxima of safety, comfort and convenience insofar as engineering ability, mechanical ingenuity and scientific research can contrive.

The following table gives an index of the extent of our industrial expansion and direct attention to the service which the railroads have rendered as builders of business by effecting a solution for the multitude of problems which such expansion has involved. And to the skill of the master car builder much of the credit is due.

Development of Car Equipment in Its Relation to Traffic

To illustrate the extent to which railroad traffic has increased the following is presented:

	1890	1920	Increase
Population	62,947,714	105,710,620	68%
Total revenue ton miles handled (in millions)	76,207	413,674	443%
Ton mile of revenue freight per inhabitant per annum	1,200	4,000	233%
Ratio increase in ton miles per inhabitant to increase in total number of population	1	3 1/3	.....

In attempting to solve this problem the railroads found by experience that a mere increase in the number of locomotives and cars of the same types and capacities as were in service twenty or thirty years ago was not a practicable solution. The adoption of such a method would result in congestion of physical plants with all the attendant evils such as traffic embargoes, exorbitant costs, etc., which would prove burdensome alike to railroads, shippers and consumers. A given mileage of main track, whether it be single, double, triple or quadruple, complemented by a given mileage of yard and side tracks can accommodate only a certain number of cars and locomotives and this situation therefore is the limiting factor as regards the number of trains that can be moved daily.

Furthermore, if the simple process of multiplying rolling stock were confronted by no obstacle other than physical limitations, the twin factors of increased capital investment and rising operating costs would act as a check upon such a method. The construction of additional track mileage, entailing enormous capital expenditures and constantly increasing expenses for maintenance, replacements, taxes, and other incidental costs, can be justifiably and economically undertaken only when maximum utilization of the existing facilities of that character has been obtained.

The necessary alternative of the railroads, therefore, has to secure the most intensive and efficient utilization of the existing plant and to accomplish this the first step was an increase in the efficiency of the motive power, thereby enabling it to haul greater loads at the same or at a lesser expense. An increase in motive power can accomplish only a very small fraction of the desired results, however, unless it be accompanied with a corresponding increase in the capacity of the freight cars and an improvement in their structural design, the cumulative effect of which is a greatly increased train load. This is the most effective method of condensing the occupancy of line and terminal trackage, thereby reducing tractive resistance by minimizing wheelage and dead-weight, at the same time decreasing maintenance costs and dead-time by curtailing the number of units, and the ingenuity and skill of the M. C. B. has made this possible.

The extent of the development from 1902 to 1921 (the last year for which complete statistics are available) is shown in the following figures:

	1902	1921	Increase
Total number of freight cars owned	1,546,101	2,378,682	54%
Aggregate carrying capacity	43,445,438	101,093,985	133%
Unit carrying capacity	28.1 tons	42.5 tons	51%
Ton-mile traffic handled (millions)	157,289	309,443	97%
Miles of yard and side tracks	58,221	100,705	73%

Had the traffic demands upon the railroads for greater carrying capacity been accommodated during the intervening years by the seemingly simple process of adding locomotives and freight cars without any attempt at changing their design or capacity, it would have been necessary to add 2,051,550 freight cars, making the total number of freight cars required under such a plan 51 per cent greater than the actual number of freight cars in service during 1921. The addition of this number of freight cars, ratably determined, would have required 77,250 miles of additional yard and side trackage, an increase of approximately 133 per cent over the trackage of 1902, or 35 per cent more yards and side trackage than was in existence in 1921. Furthermore, 22,823 additional freight locomotives—or 97 per cent more than the number in service in 1902—would have been required to handle the additional gross tonnage. It may be well to leave to your conjecture the tremendous expansion which would have been required in all other complementary facilities to accommodate the demand for increased capacity had the railroads attempted to meet the problem by the impracticable method of simply increasing the number of equipment units.

The addition of 2,051,550 freight cars alone during the 19 years referred to would have been in excess by 1,218,969 cars of the number of freight cars actually added during that period; at an average cost of $1,500 per car these 1,218,969 extra cars would have required an additional investment aggregating $1,828,454,000, the capital charges on which, alone, at 6 per cent would have amounted to $109,707,240.

Furthermore, if during the period from 1902 to 1921 the railroads had simply added 2,051,550 freight cars with an average unit capacity of 28.1 tons, corresponding to that of the equipment in service in 1902, they would have been forced to handle 6,449,000,000 additional loaded car-miles in 1921 to accommodate the traffic actually transported in that year, the direct transportation cost of which alone, on basis of 1921 costs, would have added over $300,000,000 to their expenses.

The effect upon transportation rates—which vitally affect the shipper and consumer—resulting from these inordinate increases in capital and operating expenses cannot be appraised, but it is obvious that any attempt to maintain a freight rate level sufficiently high to protect these burdensome costs would have proved inhibitive of traffic.

The output of the transportation industry is measured in traffic units of tons and passengers carried one mile, and the efficiency with which the transportation machine has functioned by reason of the increased unit capacity and weight of equipment, more intensive utilization of facilities, reduction of curvatures and gradient, etc., is strikingly reflected by a comparison of results during the period from 1890 to 1920.

	1890	1921	Increase
Population	62,947,714	105,710,620	68%
Traffic units handled (millions)	112,750	587,824	421%
Tons handled per train	177.42	652.40	268%
Freight traffic density	493,638	1,748,451	254%
Passenger traffic density	75,751	199,708	164%
Traffic unit handled per capita of population	1,791	5,560	210%
Index number of wholesale prices of commodities	82	189	130%
Average freight rate (mills)	9.41	10.52	12%

While many other illustrations could be cited to show the efficient railroad development during the last thirty years, the foregoing figures argue the case most effectively by the contrast which they present in operating results for that period.

The normal development of railroad equipment was limited by war restrictions during the four-year period, 1915-1918, and by financial restrictions during the ensuing years, 1919, 1920 and 1921, but notwithstanding the fact that only 100,000 freight cars were purchased during the 26 months of Federal control—approximately 46,000 cars per year—the average number of new freight cars added by the railroads over a period of ten years, 1913-1922, has amounted to 101,009 annually. To overcome any existing freight car shortage and to accommodate present and future traffic demands of commerce the railroads, in recognition of the necessity confronting them for the maximum improvement and expansion of their transportation facilities, expended $200,000,000 for freight cars in 1922 and have authorized additional expenditures for freight cars of, approximately, $515,000,000 for 1923. When we add to this the actual expenditures during 1922 and the authorized expenditures for the year 1923 for locomotives, additional trackage and other facilities, the sum total of money invested in expansion of railroad properties will approximate one and a half billion dollars.

Conclusion

Ninety years ago Mons. A. Notre of Paris, a farsighted Frenchman, wrote:

"The public and private advantages, already derived from this (railroad) system, have reduced it to a certainty that this mode of construction can be adopted on long roads, with a view to both swiftness and economy. Agriculture, commerce and manufacturers will acquire a new impetus, from the communication with the most distant markets, being rendered more rapid and cheaper; the poor man will no longer be obliged to deny himself that which was formerly beyond his means; the rich man will be conveyed with a velocity which formerly all his wealth could not have procured for him, and from a political and military point of view, the mind is lost in its imaginings; nations may collect their armies on their frontiers as if by enchantment.

His vision was prophetic. He painted a large picture, a picture which doubtless in his day was viewed with skepticism. Today there is still the opportunity for vision and prophecy when one discusses the subject of transportation. To a close student it is evident that the development of railroad equipment has not only kept pace with the traffic requirements of the country, but, thanks to the Master Car Builders of America, has anticipated and is anticipating the necessities and demands of the future. The art of car building has progressed from the rough and ready cut and dry methods of the old wooden car days to the execution of carefully developed engineering designs in steel construction. Experts in structural details and construction features are constantly on the job. American inventive genius year in and year out is producing specialties that increase service, give added security and keep American railroading in the van.

A German Brake Pressure Regulator

In our issue for May, 1923, we published a description of the Kunze-Knorr air brake that is being extensively used in Sweden and Germany. In close connection with the brake as illustrated for freight work, there is a high speed passenger brake that has been developed along the same lines as the freight brake that was illustrated in the article referred to.

This brake is arranged to develop a braking pressure for high speed work in the same way that the freight brake develops an extra pressure for emergencies or loaded cars.

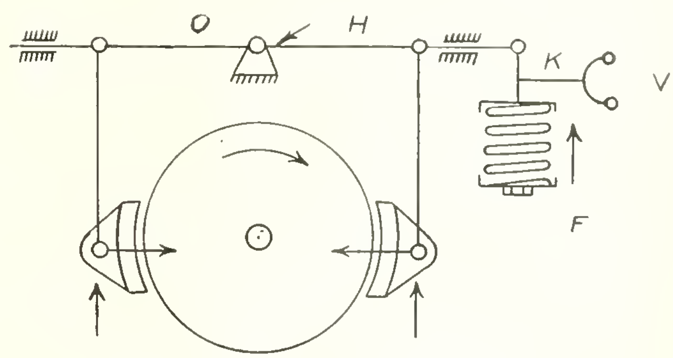
In the passenger service it is designed to develop a braking pressure equal to 185 per cent of the weight of the car, just as the Westinghouse high speed brake develops a corresponding excess of pressure.

This higher pressure is developed and used because the coefficient of friction decreases to such an extent with high speeds as to make it possible. But, as the speed decreases the brakeshoe pressure must also be decreased, else the wheels would slide.

With both the Westinghouse and Kunze-Knorr brakes this decrease is obtained by exhausting a part of the brake cylinder air as the speed of the train is decreased. The difference in the two methods is that the Westinghouse works on a time basis, while the Kunze-Knorr uses brakeshoe resistance as a basis. The Westinghouse uses what practically amounts to a safety valve that will permit the pressure to blow down to that regularly used for braking. The orifice of the safety valve is so arranged that the time required for the excess pressure to blow down to normal corresponds with that in which the speed of the train would fall from a high speed, say of 60 miles per hour to one to which the normal brake shoe pressure would be appropriate.

The Kunze-Knorr regulation, on the other hand, opens the exhaust from the brake cylinder, when the brakeshoe resistance has risen to a point slightly below the adhesion of the wheel to the rail. In other words, when the coefficient of friction multiplied by the pressure is a little less than the coefficient of friction between the wheel and the rail multiplied by the weight of the car.

As the former coefficient is constantly increasing so is the result of its multiplication by the brakeshoe pressure.



German Brake Pressure Regulator

The method by which this is accomplished is very simple in theory, and will be readily understood by a reference to the accompanying diagram.

There is a lever *H* which is pivoted at the center *O*. The brake hangers are attached to either end, and it is evident that the frictional resistance of the two shoes tends to turn the lever in the same direction.

An extension of this lever has a connection to a stem attached to the seats of the spring *F*. These are arranged like the draft springs on an American car, so that the spring is compressed regardless of whether the stem is in tension or compression. Attached to the stem of the spring there is an arm leading out to a valve at *V*. As this arm is moved out of its normal position the valve opens the exhaust from the brake cylinder.

The spring is so adjusted in its seat that when the combined thrusts of the two brake shoes on the lever *H* amounts to the predetermined percentage of the adhesion of the wheel and the rail, the lever will be so moved as to cause the valve *V* to open the exhaust. This, at once, reduces the brakeshoe pressure and the spring draws the lever *H* back towards its horizontal position, closing the valve until the decreasing speed causes such a further rise of frictional resistance as to again open the valve.

In principle, then, this device serves to hold the brakeshoe resistance below the adhesion of the wheel to the rail and automatically compensates for variations in the coefficient of brakeshoe friction arising from difference in material, speed and temperature.

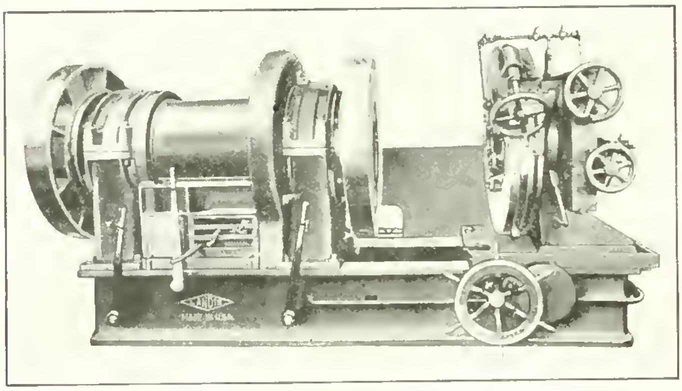
The apparatus is shown in the detail engraving. There is a casing surrounding the spring with a follower at each end by which it is compressed regardless of the direction of motion of the stem. The upper, forked, end of the stem *K* has a recess in which the arm of a triangular lever similar to the lever of the ordinary conductor's valve is inserted. Any movement of this arm will move the valve *V* to the left and thus open the communication to the brake cylinder. The valve *V* being held normally closed by the spring as shown.

The Landis 18″ Pipe Threading and Cutting Machine

The Landis Machine Company, Waynesboro, Pa., have added to their line of pipe threading and cutting machines an 18″ size. The range of this machine is from 8″ to 18″ and this entire range is covered by one die head and set of chasers.

The length of the machine is 12′ 2″, the height is 6′. The extreme width of the machine, belt driven, over the belt pulley is 5′ 10″, while the extreme width of the machine, motor driven, over the motor plate is 6′ 8″. It weighs 22,000 pounds.

The machine has a single pulley drive and the variations in speeds, which are eight in number, are obtained by means of a speed box located beneath the main spindle. A friction clutch is mounted on the main drive shaft with the pulley, or if driven by electric motor a chain



New Landis Pipe Threading and Cutting Machine

sprocket will be substituted for the pulley. The operating cone of the clutch is moved by two levers which are located at the ends of the head stock within easy reach of the operator. The forward lever is used when threading pipe, while the lever at the rear end of the machine is used for starting and stopping when making up flanges. The lever in the middle is for reversing.

All gears are fully enclosed and with the exception of the main driving gear and its pinion they run in an oil bath. The main bearings of the hollow spindle are lubricated with flat link chains which run in oil contained in large reservoirs in the base. The driving pinion shaft, as well as the reverse shafts are lubricated by sight feed oilers.

At each end of the hollow spindle there is a three-jawed independent chuck for holding the pipe. The rear chuck is equipped with flange grips for fitting flanges.

The carriage which supports the die head, the cutting-off tool and the reaming tool are moved either by power or by hand. The power traverse or movement is both forward and backward and is controlled by a lever located on the operating side of the carriage. In advancing the carriage toward the chuck, the lever is pulled and held until the threading position for the die is reached. In reversing the movement of the carriage, the lever is pushed forward and held. Releasing the lever stops the carriage at any point within its travel.

Automatic stops prevent the die head from coming in contact with the chuck in the forward movement and the carriage from running off the guides of the machine in the backward movement. The reaming tool is quickly set to position and locked with a lever.

The machine is converted to motor drive by replacing the pulley with a sprocket and mounting the motor on a base over the gear box. A silent chain is employed to drive from the motor to the sprocket.

The machine employs the Landis long life tangential chaser.

The Flannery Staybolt Tester

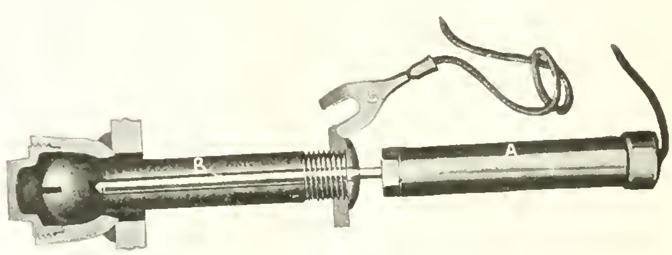
The inspection and testing of the Tate flexible staybolt as made by the Flannery Bolt Co. of Pittsburgh, Pa., has heretofore been a troublesome piece of work, to say the least It has been necessary not only to remove the lagging but also the cap from each individual staybolt and even then the inspection might fail to detect a cracked or partially broken bolt.

The method pursued, according to one authority, was to "remove all caps and strike the head of the bolt two or three good smart blows, so as to finish the break if possible; then a round-nose tool is taken and the head struck first on one side and then on the other, twisting it so that, in case it is fractured, it will break loose." Certainly a long and expensive method.

The Flannery Bolt Co. has recently developed a method of testing these bolts that avoids the necessity of removing the caps and lagging.

The method requires no change in the standard parts of a flexible staybolt assemblage, with the exception of providing a bolt with a tell-tale hole extending from the inner end into but not through the head of the bolt.

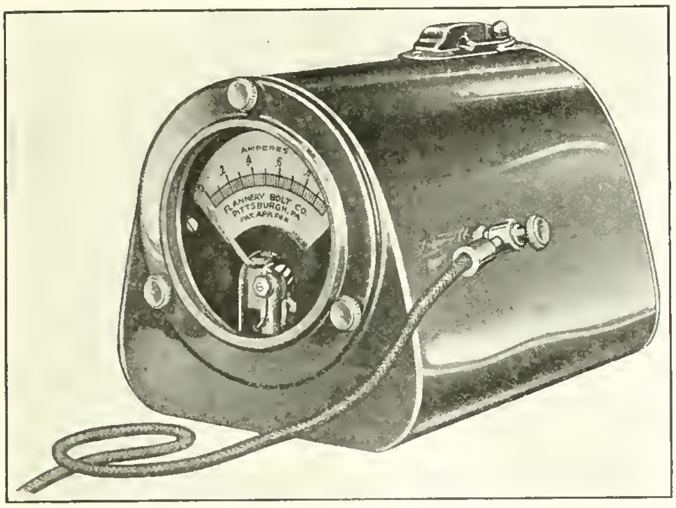
The apparatus consists of two parts: One a small ammeter capable of indicating the presence of very light electrical currents; the other is an insulated handle *A*, from one end of which an insulated stem *B*, having an exposed contact point, projects. This stem is connected to one pole of the ammeter by an insulated wire. The



Contacts New Flannery Electric Staybolt Tester

other pole is connected by a similar wire to the contact piece *C*. It is evident that if a metallic connection is made between the contact piece *C* and the exposed point *D* of the stem *B* the electrical circuit will be closed and the flow of the current will be indicated by the ammeter pointer. The battery used is a single cell such as is used for small flashlights, and as there is space in the ammeter casing for three of these batteries a large number of staybolts can be inspected before the three are exhausted.

The method of using the apparatus is to push the end of the insulated stem into the hole until the point strikes the bottom of the same. The contact piece is then laid against the inside sheet of the firebox. If the hole is clear the circuit is completed. If it is not clear it will simply be necessary to run a drill in to clean out the hole of accumulated dirt and cinder. With the electrical

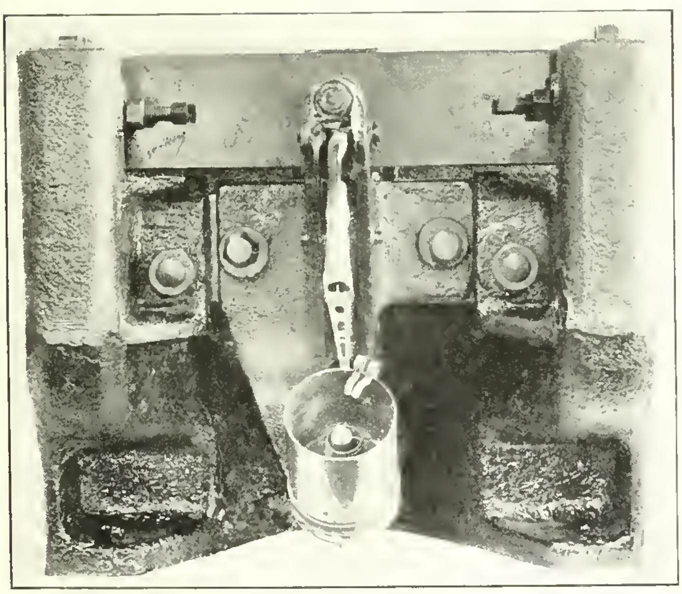


Ammeter of Flannery Electric Staybolt Tester

circuit completed a clear hole is insured. After the inspection has been made in this way the boiler is subjected to a hydrostatic test, when every bolt that is cracked in to the tell-tale hole will show a leak. This insures the detection of every bolt that is so cracked that the fracture extends in to the hole and that without any expensive disturbance of the outer covering of the boiler.

Device for Measuring Wheel Thrust or Impact on Rails

An interesting device known as an otheograph which is in effect a test tie for measuring simultaneously the



End View of Otheograph Showing Recording Drum

vertical and transverse thrust or impact of a wheel on a rail, has been recently developed by the General Electric Company and a number of these ties are being installed on the company's test tracks at its Erie, Pa., works.

The instruments illustrated in Fig. 1 shows by graphic records the effect of each separate wheel of a locomotive or car on each of the two rails. These otheograph ties may be installed in place of the regular ties, either singly or several grouped together on curves or tangent track. Provision is made for two different springs for recording the vertical load, one having a deflection of about 1/8" each 25,000 pounds axle loading, the other spring for heavier weight, having the same deflection for 50,000 pounds axle loading. The springs are designed for a maximum deflection of 3/8". Springs recording the transverse thrust have deflection of about 1/8" for 20,000 pounds. The deflection of the spring is recorded through a lever having a ratio of 8 to 1, the record being traced on paper wrapped around a revolving cylinder similar to an engine indicator. The operating mechanism provides for moving the recording cylinders simultaneously so that as many records may be taken of each wheel on each side of the locomotive as the number of ties that are grouped together.

Testimonial to Mr. S. M. Vauclain

From railway shopman to president of the Baldwin Locomotive Works, doing a business of more than one hundred million dollars ($100,000,000) annually and employing more than twenty thousand (20,000) men, is an achievement of which few men can lay claim even in this land of golden opportunity, yet this is the record of S. M. Vauclain.

Last year Mr. Vauclain did much to dispel gloom and restore confidence in the railway, industrial and commercial fields through the medium of the prosperity special consisting of some thirty-five (35) new locomotives for the Southern Pacific Company operated as a special train from Philadelphia to Houston, Texas.

In April this year Mr. Vauclain and party took a swing around the Southwestern and Southern circle, calling on railway officials and spreading the gospel of "Prosperity, Good Will and the Square Deal" in many addresses before chambers of commerce, educational institutions and civic bodies in various cities.

The trip as reported by Mr. Grafton Greenough in the "Log of the Philadelphia," seemed to have been one continual ovation to Mr. Vauclain, and no doubt cleared the atmosphere to the eyes and minds of many on subjects of vital importance both at home and abroad.

Scholarship at Stevens Institute of Technology

The Mechanical Division of the American Railway Association has four scholarships at Stevens Institute of Technology, Hoboken, N. J., two of which became vacant last month. These scholarships are available for the sons of members of the Division and cover the regular tuition charges for a four-year course, leading to the degree of Mechanical Engineer (M. E.). The course offered also includes instruction in electrical, civil and other branches of engineering.

Applications for these scholarships should be in the hands of the secretary as promptly as possible. In case there are more than two applicants, they will be given to the two passing the entrance examination with the highest standing.

Full information as to course of study, entrance requirements, arrangements for examination, etc., will be supplied by the secretary, V. R. Hawthorne, 431 South Dearborn St., Chicago, Ills.

Snap Shots—By the Wanderer

There is often some doubt expressed as to the value of railroad advertising and there is more than a possibility that some of it may not give results commensurate with the outlay. I sometimes wonder whether it is possible for a big road that advertises a scenic route to which less than one per cent of its passengers pay any attention to check back and determine whether it gets a return for its money. Once in a while, however, there seem to be immediate and tangible results. The transportation system of New York is overworked.

An advertising campaign was entered upon to try and induce people to use the elevated instead of the subways. The cars on the elevated were painted a bright orange color and they were called the "Open Air Route." The public were told that they were running quite as fast and making as good time as the subway, and the advertising was pushed with vigor. The result is that to those who were using the elevated service, before, there came a crowding to which they were not accustomed and the management reports a larger increase of traffic within the past three months than in the three years previous. As a matter of fact the management did not put things as strongly as they might. They simply said that the elevated made as good or nearly as good time as the subways. But personal experience shows that it is possible to walk a half mile to the elevated instead of two blocks to the subway, and beat the latter, to a downtown office, by five or more minutes during the rush hours of the morning, and from fifteen to twenty minutes on the return trip at night. And all because of subway congestion and delays at heavy express interchange points.

But as a subway official said: "You know it and I know it, but it is difficult to make the public believe it." They take what is handiest and then grumble at the railroad.

It has been said that a democracy knows no gratitude I wonder sometimes whether the slur might not be broadened so as to include all of humanity and corporations. How many corporations either as a body or as individuals, as represented by their officers, have much regard for the men on whom their greatness was founded, or to whom they owe all that they are? And I fear that railroads must be included in the general statement.

To cite a case in point. A certain railroad was noted for its greatness. And it *was* great in very many ways and in many departments. But there was one department that stood out pre-eminently above the others. It had not only a national but an international reputation, and this was due mainly to the quiet man at its head—the one responsible for all of its actions. A man who had the absolute confidence of his superiors, and of the public who knew of his work.

In the course of human events he passed on to the great beyond, and feeling that what he had done was too important to be forgotten, a memoir of his works was prepared, and in its preparation his relationship to the road was kept so constantly in mind that when it was finished it was found to be not only the life of a man but the story of a period, a period during which the road had grown to greatness. But it was too late. He had been forgotten and when it was apparent to the president he declined to take the trouble to have it typewritten and bound for the library which the man, of whom it told, had founded. Here was a case where like "the pyramids themselves, doting with age, have forgotten the names of their founders."

With reference to the forgetfulness of those who have laid the foundations for our success I wonder how much the aviators of today appreciate the work done by Langley. Also as to how much use is made of his scientific researches as such in the design and construction of the present day aeroplane. It is a curious commentary on the futility of human endeavor that Prof. Langley worked for years in the determination of the propelling power of innumerable forms of wheels, and in the lifting power of almost every conceivable shape of wing and plane. He was laughed at and called visionary and generally regarded as in pursuit of a will-o'-the-wisp. Then came the Wrights who started at the other end and came back to meet him. Langley started out to prove mechanical flight a possibility, the Wrights started out to fly. They built gliders first, and learned to balance themselves in them before they applied power. Langley first developed a plane surface that would support a weight when moving through the air, then he put a motor behind it. He was handicapped by lack of a suitable motor, for the internal combustion engine had not then reached its present degree of perfection, and he was obliged to use steam on the one successful plane that he built. Prof. Langley apparently failed to appreciate the importance of balance. His successful aeroplane was so carefully adjusted in all its parts that it maintained itself in proper position throughout the whole period of its flight. The Wrights found that balance was the key to the situation. They balanced themselves first and then flew. The two processes are often repeated in everyday work. The Wrights represented the cut and try, or trial and error method; and after all that is about the only way in which a successful development can be effected.

A notable instance is the injector. The principle was worked out theoretically abroad and shown that it could put water into a boiler under pressure. But how woefully far the early mechanisms fell short of being practical and reliable, only those old stagers who were in at the birth and had to struggle and put up with its idiosyncrasies and vagaries can realize. Of all kittle cattle that was ever foisted upon a reluctant roundhouse force and a stubborn engine crew, the early injector took the lead. It was a long road and the old plunger pump remained on the left hand side for many a year in order to insure the engine against a water failure. I wonder now as to how long the injector will be kept on in order to insure against the same failure because of the feed water heater.

So Italy is tired of government railroad operation is she? We had our own fill in the few months of Federal control and we look back on it as a sort of nightmare, over which the "I-told-you-sos," gloat with a sort of shuddering complacency, the moderates who were inclined to think well of government operation, have withdrawn support and cry "enough is enough;" while the hard and fast dyed in the wool Plumb plan advocates—well a "man convinced against his will is of the same opinion still."

Then our Canadian neighbors, if rumor speak true, are not altogether enamored of their own experience.

But Italy! Never was there a more complete surrender. She took over the railroads a few years ago and great was the success she was going to make of them. And now she is down on her knees begging someone to take them off her hands. That someone can have them about on his own terms. He can be Italian, French, English, anyone who has the capital. Rental is cut so that it almost disappears and the concessionaire will have rights and privileges galore. Well! It is refreshing to see a people, who are sick of a bad bargain, so perfectly frank and eager to get rid of it.

Belgian Railroad Deficit Cut in 1922

Owing to increasing receipts in 1922 the annual deficit of the Belgian State Railroads was cut to 33,000,000 francs, according to a late official estimate, received by the Department of Commerce. The deficit in 1913 was 15,404,861 francs. Actual receipts for 1922 amounted to 1,109,817,540 francs or 109,817,540 francs above the budget estimate. During the first two months of 1923 the receipts exceeded the estimate by 23,870,000 francs. Progress in lowering expenses was made last year but increased fuel costs and wages may result in increasing expenses in 1923.

Fuel consumption per locomotive kilometer in 1921 was reduced 22 per cent below that for 1920, as the result of better attention by employes, encouraged by bonuses for good records in fuel economy. The consumption in 1922 was still, however, nearly 29 per cent over that of 1913, as the result of using higher-powered locomotives. Complete statistics on fuel consumption for 1922 are not yet available. The sharp rise in coal prices is due to difficulty in obtaining coal from the Ruhr, the uncertainty of future supplies and the shortage of Belgian coal.

Strenuous efforts to reduce the personnel resulted in only 100,906 officials and employes being provided for in the budget for 1922, compared with 115,000 in 1921. The eight-hour law requires a larger number than in 1913 when there were 75,000 employes. Increased cost of living has caused the employes to demand more pay and this may mean increased expenses to be met from the state treasury.

There were 5,433 locomotives of 117 types owned by the Belgian Railroad Administration on December 1, 1922. Of these 3,488 were in service, 1,122 under repair and 823 held for sale. Such a variety of power units resulted from the rapid accumulation of equipment after the Armistice and makes upkeep expensive. One thousand nine hundred and sixteen of these locomotives of 16 types designated as "standard" have been selected as a nucleus of power equipment and the remainder will be replaced gradually by units of standard types.

The number of freight cars has increased from 92,857 in 1914 to 122,000 in 1922, with 12,600 still due from Germany. Since 100,000 cars are considered sufficient, with an additional 10,000 for exceptional needs, there is a surplus of equipment which hinders traffic.

One thousand three hundred and fifty-five passenger train cars have been added since 1921, bringing the total to 11,253, almost equal to the 1914 figure of 11,810 cars. The variety in types of equipment causes difficulty in maintenance.

The plan for standardizing equipment which is expected to result in more economical operation has been started by the sale of 749 locomotives, 924 tenders and 10,000 freight cars for scrap.

Japanese Railways to Spend $20.000.000 for Equipment

The Japanese Department of Railways has decided to spend 40,286,000 yen (approximately $20,000,000) within this fiscal year for the construction of locomotives and cars..

Last year many electric locomotives were ordered from British and American makers. The number of electric locomotives to be acquired this year is stated to be 27.

Passenger cars are to be built to the number of 485 and 176 electric cars. Only one-half of the goods wagons built last year are to be constructed this year but still their number totals 1,609.

Notes on Domestic Railroads

Locomotive

The Missouri Pacific Railroad is having 100 locomotives repaired at the shops of the Morgan Engineering Works, Alliance, Ohio.

Mitsui & Company, New York City, are inquiring for 8 tank locomotives for the Chosen-Sangyo Railway, Japan.

The Kanawha & Hocking Coal & Coke Company, Cleveland, is inquiring for one Mikado type locomotive.

The Atlantic Refining Company has ordered one 0-4-0 switching locomotive from the Baldwin Locomotive Works.

The Nashville, Chattanooga & St. Louis Railway contemplates coming in the market soon for a number of locomotives.

The Central Vermont Railway has ordered 16 Consolidation type and 8, 0-8-0 type switching locomotives from the American Locomotive Company.

The Arcia-La Paz, Chile, has ordered one Mallet type locomotive from the Baldwin Locomotive Works.

The Alton & Southern Railroad has ordered one locomotive from the American Locomotive Company.

The Atchison, Topeka & Santa Fe Railway has ordered 30, 2-8-2 type locomotives from the Baldwin Locomotive Works.

The New York Central R. R. Co. has ordered 5 Shay geared locomotives from the Lima Locomotive Works.

The Sewell Valley R. R. Co. has ordered one Mikado type locomotive from the Lima Locomotive Works.

The Caldas Railway, Colombia, has ordered one Mikado type locomotive from the American Locomotive Company.

Passenger Cars

The Southern Pacific Co. has ordered 16 steel baggage and buffet cars from the American Car & Foundry Company.

The Missouri Pacific R. R. is inquiring for 18 coaches, 10 baggage, 12 chair, 9 divided coaches, 8 dining cars and 3 cafe club cars.

The Lackawanna & Wyoming Valley Railroad is inquiring for 10 cars for passenger service.

The Lehigh & New England Railroad is inquiring for one private car.

The Pacific Electric Railway has ordered 50 electric motor coaches, 42 ft. long, from the Standard Steel Car Company.

The American Short Line Railroad Association's consolidated purchasing agency is in the market for three used steel underframe coaches.

Freight Cars

The Pere Marquette Ry. has ordered 25 steel center constructions for caboose cars from the Pressed Steel Car Company.

The Canadian National Ry. has ordered 750 box cars of 50 tons capacity from the Canadian Car & Foundry Company and 250 from the National Steel Car Corporation.

The Southern Railway is inquiring for prices on 1,000 steel center constructions for box cars.

The New York Central Railroad Co. is inquiring for from 100 to 500 all steel hopper car bodies of 55 tons capacity.

The Atchison, Topeka & Santa Fe Ry. is inquiring for 300 end gondola cars.

The Erie Railroad is having repairs made to 200 produce cars at the shops of the Illinois Car Company, and is also having repairs made to 200 gondola cars by the Greenville Steel Car Company.

The Baltimore & Ohio R. R. has ordered 100 four-wheel steel tie cars and 15 four-wheel steel piling cars from the Pressed Steel Car Company.

W. H. Bradford & Company, Inc., Commercial Trust Building, Philadelphia, Pa., is inquiring for 200 coal cars of 55 tons capacity.

The American Short Line Railroad Association, consolidated purchasing agency is in the market for 50 used steel-underframe, 40-ton box cars, 85 used steel underframe 40-ton gondolas, 68 used steel underframe, 40-ton flat cars and 10 used eight-wheel cabooses.

The Lehigh & New England R. R. has placed an order with the Mogor Car Corporation to repair 150 steel hopper cars and an order has been placed with the Middletown Car Company for repairing 150 steel hopper cars.

The Minnesota Steel Company is inquiring for 44 hopper cars of 55 tons capacity.

The Central of New Jersey will have 300 hopper cars repaired in the shops of the Middletown Car Company.

The Pan American Petroleum Company has ordered 10 tank cars of 10,000 gal. capacity from the American Car & Foundry Company.

Mitsui & Company, New York City, are inquiring for 80 dump cars, for export to Japan.

The Union Railroad will have 100 Clark dump cars built in the shops of the Greenville Steel Car Company.

The Atchison, Topeka & Santa Fe Ry. is inquiring for 200 flat cars.

The New York, Chicago & St. Louis R. R. is inquiring for 10 underframes for caboose cars.

The New York, New Haven & Hartford R. R. contemplates having about 2,000 freight cars repaired in the shops at the Keith Car & Mfg. Company.

The Chicago, Burlington & Quincy R. R. has placed an order with the Pullman Company for repairs on 600 coal cars.

The Standard Oil Company of New Jersey, has ordered 12, 50 tons steel dump cars from American Car & Foundry Company.

The Central R. R. of New Jersey is inquiring for repairs to 300 box cars.

The Canadian Pacific is having 1,000 steel underframe double sheathed box cars, 36 ft. long also 300 steel frame automobile cars 40 ft. 6 in. long built in its Angus Shops.

The Mississippi River & Bonne Terre Railway is inquiring for 50 box cars.

The Delaware, Lackawanna & Western R. R. Co. is inquiring for 200 refrigerator cars of 40 tons capacity.

The Pere Marquette Railway Co. is inquiring for 500 steel underframes for refrigerator cars.

The Canadian National Railways is inquiring for 1,000 automobile cars of 40 tons capacity.

The Chesapeake & Ohio Ry. is inquiring for three refrigerator cars.

The Philadelphia & Reading Ry. is in the market for repairs to 400 hopper cars.

Building and Structures

Chicago & Northwestern Ry Co. has plans for the construction of a new engine house and repair shop at Blunt, So. Dak.

Illinois Central R. R. Co., plans the construction of additions to locomotive shop and car repair shop at Jackson, Tenn., to cost approximately $200,000.

Chicago, Burlington & Quincy R. R. plans the construction of a new engine house and repair shop at Mendota, Ill., for which bids will be called for in the near future.

Atchison, Topeka & Santa Fe Railway Co. will soon call for bids for the construction of new shop facilities at San Bernardino, Calif., to cost approximately $350,000

Chicago, Rock Island & Pacific Railway Co. plans the construction for a new roundhouse at Hutchinson, Kansas, to replace the one recently destroyed by fire.

Elgin, Joliet & Eastern Railway Co., will construct a new car repair shop at Joliet, Ill., to replace the building recently destroyed by fire, and will cost approximately $500,000.

Union Pacific System has awarded a contract to the Graver Corporation, East Chicago, Indiana, for a 25,000 gallon per hour capacity water treating plant at Armstrong, Kansas, and one of the same capacity at Marysville, Kansas.

Western Pacific Railroad Co., has awarded to the W. Murcell Company, San Francisco, Calif., for the construction of an addition to its locomotive and car shops at Sacramento, Calif.

Michigan Central R. R. Co. has awarded a contract to the Ellington Miller Company, Chicago, Ill., for the construction of an 8-stall reinforced concrete roundhouse, a boiler house, an office building and sanding facilities at Grand Rapids, Mich., to cost approximately $100,000.

Pennsylvania R. R. has commenced the construction of a new two-story machine shop at Mt. Vernon, Ohio, to replace a building recently destroyed by fire.

Southern Pacific Company has authorized the construction of a locomotive assembly shop at Los Angeles, Calif., to cost approximately $500,000.

Ft. Worth & Denver City Ry. Co. will construct temporary shops at Childress, Texas, to replace buildings recently destroyed by fire.

Union Pacific R. R. Co. will construct a new six-stall roundhouse at Topeka, Kansas. They also plan the construction of a new machine shop at Topeka, Kansas.

New York Central Railroad has prepared for the construction of a new engine house with repair shop at Oswego, New York.

Atlantic Coast Line Railroad is reported to have approved an appropriation of $1,800,000 for extensions in car and locomotive shops.

St. Louis, San Francisco Railway has awarded a contract to the T. S. Leake & Company, Chicago, Ill., for the construction of its new car and locomotive shops at St. Louis, Mo.

New York, New Haven & Hartford Railroad is reported to have awarded a contract to the H. Wales Lines Company, of Meriden, Conn., for the construction of a new engine house with repair facilities.

The Illinois Central Railroad has contracted with the Graver Corporation, East Chicago, Ind., for the erection of Graver Type "K" water softening plants of from 20,000 to 30,000 gals. per hour capacity to be erected at Webster City, Iowa Falls and Parkersburg, Iowa, and Dixon, Ill.

Supply Trade Notes

Manning, Maxwell & Moore, Inc., has removed its offices from 119 West 40th street, to the Pershing Square Building, 100 East 42d street, New York City.

J. A. MacLean, vice-president and general manager of the **Boss-Nut Division of American Bolt Corporation,** has had his jurisdiction extended over the other divisions of the American Bolt Corporation which are at Bayonne, New Jersey, Detroit, Mich., and Columbus, Ohio.

R. P. Barnett is now connected with the **Franklin Railway Supply Company, Inc.,** New York, as Service Engineer. Mr. Barnett entered the employ of the Norfolk & Western Railway Co., 1896, as clerk in the store house, at Radford, Virginia. One year later he accepted a position as fireman on the Radford Division. After firing for two years on the Norfolk and Western, he went with the Southern Railway, Knoxville Division. He fired for some months on the Southern, and was then promoted to Engineer. With the exception of a period of three years, during which he returned to the Radford Division to run an engine, Mr. Barnett was in continuous service on the Knoxville Division of the Southern. For two years he was a Road Foreman of Engines. He left the Southern recently to join the Franklin Railway Supply Company, Inc.

The Crandall Packing Co. is under new management and the changes are as follows: President and general manager, **H. N. Winner,** former manager of Packing Department of the United States Rubber Co. and manager of the Philadelphia Branch of the Garlock Packing Company; vice-president and treasurer, **R. M. Waples,** formerly in the Packing Department of the United States Rubber Co. and the Garlock Packing Co.; secretary, **R. P. Engle,** of Palmyra, New York; manager of the New York Branch, **E. P. Watrous,** formerly manager of the New York branch of the Garlock Packing Company; manager of the Birmingham Branch, **I. D. Lyon,** formerly manager of the Clinton Manufacturing Co. and of the Mechanical Goods Division of the Goodyear Tire and Rubber Co. The rest of the branches and main office officials are the same as formerly.

Earnest Keathley has joined the **Franklin Railway Supply Company, Inc.,** New York, as service engineer. Mr. Keathley served his apprenticeship with the Chesapeake and Ohio Railroad at Huntington, West Va. He was for a year superintendent of the steel car shop of the American Car and Foundry Company at Huntington, West Va. For 12 years he was connected with the Union Iron Works, Selena, Alabama. Mr. Keathley represented this company on the road, selling railroad supplies of all kinds. In 1916, he returned to railroad work as general foreman of the Southern Shops at Knoxville, Tenn., which position he recently resigned to join the Franklin Railway Supply Company, Inc.

The American Steel Foundries has leased the fifteenth and sixteenth floors of the Wrigley Building annex Chicago, Ill., for ten years commencing May 1, 1924, at which time it will move its general offices from the McCormick building.

The American Steel Foundries are negotiating for the purchase of the Damascus Brake Beam Company.

The Latrobe Tool Company, manufacturers of high speed drills and reamers, Latrobe, Pa., has moved its Chicago, Ill., warehouse to 1440 West Lake street.

A. F. Schmubl has been appointed general lumber agent of the Pullman Company with headquarters at Chicago, Ill., succeeding **A. F. Jones** assigned to other duties.

Harry Vissering, president of **Harry Vissering & Co.,** Chicago, Ill., has been made president of the Railroad Supply & Equipment Exchange Corporation, recently incorporated for the purpose of erecting in Chicago a large building to be used as a central headquarters for the railway supply trade of the United States. The building, as planned, provides space for exhibitions of railway equipment and supplies and also office space for supply manufacturers and their representatives, the upper floors to be used for club rooms.

Calvin L. Jones, welding engineer of the **Westinghouse Electric & Manufacturing Co.** at Atlanta, Ga., has been elected vice-president of the American Welding Society. Mr. Jones has been elected for a two-year term and will be in charge of the activities of the Society in the Southern division.

W. J. Leighner has been appointed works manager of the **George Cutter Company**, a subsidiary of the **Westinghouse Electric & Manufacturing Co.**, located at South Bend, Ind.

The Ohio Brass Company announces the appointment of **James H. Drew** as manager of the line material division, effective July 1, 1923. Mr. Drew was one of the original founders of the Indianapolis Brass Co.

Leo Ehlbert, formerly with *Engineering & Contracting*, has been appointed Western representative with headquarters at 605 Fisher building Chicago, of the **Railway Equipment & Publication Company**, New York, publishers of the Pocket List and the Equipment Register, succeeding **Charles L. Dinsmore**, who has retired after 20 years of service as Western representative of this company. In tendering his resignation, Mr. Dinsmore acted upon the advice of his physician who has been urging him to retire for the past year.

Frank H. Clark, who was president of the **Elvin Mechanical Stoker Company** in 1917 when the stoker was being developed and who subsequently became vice-president of the **Bradford Draft Gear Company**, New York City, has been elected vice-president of the Elvin Mechanical Stoker Company in an executive and sales capacity, with headquarters in New York. Mr. Clark will remain also as director and vice-president of the Bradford Draft Gear Company.

Items of Personal Interest

G. M. DeGure has been appointed manager of the department of the Railroad Administration succeeding Frank McManamy who has been appointed Interstate Commerce Commissioner.

J. L. Beven has been appointed assistant to the president of the Illinois Central with headquarters at Chicago; he formerly was assistant to the senior vice-president.

H. A. Macbeth, assistant superintendent of motive power of the New York, Chicago & St. Louis R. R. Co., with headquarters at Conneaut, has been appointed superintendent of motive power of the Wheeling & Lake Erie Railway with headquarters at Brewster, Ohio.

W. H. Fetner, superintendent of motive power of the Central of Georgia with headquarters at Savannah, Ga., has been appointed assistant to the president of the Missouri Pacific with headquarters at St. Louis, Mo.

C. L. Dickert, Master Mechanic on the Central of Georgia with headquarters at Macon, Ga., has been promoted to superintendent of motive power with headquarters at Savannah, Ga., succeeding W. H. Fetner, who resigned to become assistant to the president of the Missouri Pacific Railroad.

A. J. Flowers, master mechanic on the Central of Georgia, with headquarters at Columbus, Ga., has been transferred to Macon, Ga., succeeding C. L. Dickert, who was promoted to superintendent of motive power with headquarters at Savannah, Ga.

W. A. McCafferty, assistant master mechanic on the Central of Georgia with headquarters at Macon, Ga., has been promoted to master mechanic with headquarters at Columbus, Ga., succeeding Mr. Flowers.

E. L. Cox, of the Central of Georgia, has been appointed assistant master mechanic, with headquarters at Macon, Ga., succeeding W. A. McCafferty.

B. P. Johnson, master mechanic of the Northern Pacific Ry. Co., with headquarters at Seattle, Wash., has been promoted to acting general master mechanic with headquarters at Livingston, Mont., succeeding T. J. Cutler.

M. A. Smith has been appointed assistant superintendent of motive power of the Pittsburgh & Lake Erie R. R. Co., with headquarters at Pittsburgh, Pa., succeeding L. H. Turner assigned to other duties.

J. P. Wadsworth has been made car foreman of the Grand Trunk Ry., with headquarters at Ottawa, Ont., Canada.

H. A. Amy, master mechanic of the Canadian Pacific Ry., with headquarters at Ottawa, Ont., has been transferred to Smith Falls, Ont., Canada.

E. W. Peacock has been made road foreman of engine on the Union Pacific at Laramie, Wyo., vice, **R. W. Robinson**, transferred to the Nebraska division; **E. P. Lee** has been made traveling fireman at North Platte, Neb., vice, **F. H. Moore** assigned to other duties.

J. J. Horrigan has been made general foreman of the Union Pacific shops at Armstrong, Kans., succeeding John Gogerty, promoted.

George Fisher has been made superintendent of the car equipment of the Canadian National Ry. with headquarters at Toronto, Ont., Canada.

Obituary

L. W. Hendricks, mechanical superintendent of the Bangor & Aroostook Railroad was killed on July 12 in an automobile accident near St. Agatha, Maine.

William Moir, who retired as mechanical superintendent of the Northern Pacific Railway Co. in 1911, after serving the company in various capacities for nearly 30 years, died on June 26, at Tacoma, Washington.

Lowell D. Kenney, assistant superintendent of transportation of the Delaware & Hudson Co., died on June 26 at the Albany City Hospital, Albany, New York, from injuries received from being hit by a batted ball during an outing. Mr. Kenney participated in the baseball game, receiving the blow which proved fatal. Mr. Kenney entered the service of the Rutland Railroad as clerk in the trainmaster's office later being made traveling car agent and remaining with that company fifteen years.

In 1916 he took a position in the transportation department of the Delaware & Hudson Co., and in 1920 was appointed statistician for operations, and on January, 1923, to assistant superintendent of transportation.

New Publications

Timothy Hackworth and the Locomotive, by Robert Young, M. I. Mechanical Engineer, 406 pages, 168 illustrations. London: The Locomotive Publishing Co., Ltd.

This is a most interesting contribution to our knowledge of locomotive history. The opinion is altogether too popular that the invention of the locomotive was the work of a single individual and as the author very properly states in his opening chapter no single person invented the locomotive. It was a gradual growth from very small beginnings, a combination of inventions, not the handiwork of one man, but evolved from the labors of many, and of some of these the world knows but little. As the years passed these discoveries were blended in one harmonious whole, the early crudities removed, the virtues perfected until today the locomotive stands out perhaps the most finished example of mechanical art ever produced. The author is a lineal descendant of Timothy Hackworth, and writes not only from inside family knowledge, but also with the added advantage of reference to original letters and documents, some of which he quotes in full.

Chapters I. and II. deal with the early history of the locomotive from Cugnot to Trevithick, and thence take us to the year 1811, when Hackworth, then twenty-four years of age, comes upon the scene as foreman-smith at Wylam Colliery. It is pleasant to note the author's suitable appreciation of the work of Richard Trevithick, and due mention is made of the cranked axle in Trevithick and Vivian's patent engine of 1802. Chapter III. gives a very interesting account of the "grasshopper" or Wylam "dilly" locomotives, which were made with Hackworth's assistance to Christopher Blackett's and Hedley's instructions. The credit for the use of a smooth wheel on a smooth rail, which has been acclaimed for Hedley, is rightly given to Trevithick's Pen-y-darran locomotive, "which progressed simply by the adhesion of the wheels." Chapter IV. deals with the Blenkinsop-Murray rack-rail locomotive, and also with the walking locomotive by William Brunton of Butterley.

The early Killingworth engines of George Stephenson are fully considered by Chapter V. It will be remembered that the axles of these engines were coupled by means of chains, and the author points out that the first locomotive in which direct coupling rods were used was the Stockton and Darlington, No. 1 "Locomotion," which was built at Stephenson's Newcastle factory in 1825. For a short time Hackworth was temporarily employed by R. Stephenson & Co. during the early period of the building of this engine, and the author states that the coupling rods on the wheels were Hackworth's invention.

In Chapter VIII., "The Railway in Operation," there is a very interesting account of Hackworth's work in improving the stationary engines and drums used for working the Brusselton and Etherley inclines.

Chapter IX., "The Locomotive Crisis," described the early troubles on the Stockton & Darlington Railway, with the first engines of the "Locomotion" type. Naturally there were defects to be expected in such machines in their infancy. Hackworth had daily opportunities of noting the defects of engines, and his practical observations led up to the design of "The Royal George" of 1827, a full description of which is given in Chapter X.

Chapter XI. contains the account of the Rainhill contest. Of Hackworth's "Sanspareil," a full sized model was made in 1893 by the Baltimore & Ohio Railway for the Chicago Exhibition of that year.

Chapter XII. deals fully with the invention of the blast pipe, a subject which has always caused much controversy. On behalf of Hackworth's claims the author unfolds his story generally with fairness, and quotes his authorities.

Chapter XIII. contains illustrations of some interesting early locomotives, and also discusses another vexed historical question, viz.: the origin of the locomotive double crank axle. This involves a "triangular duel" between the claims of Hackworth's "Globe," Stephenson's "Planet," and Bury's "Liverpool."

Locomotive progress from 1830-1834 is considered in Chapter XIV., which contains many historical particulars of the early Stockton and Darlington engines, both of Hackworth's and other designs. In 1833, Hackworth made a new agreement with the railway company, by which he contracted to provide and maintain in good condition the whole of the locomotive power. In virtue of this, Hackworth obtained complete independence of action, and built his own shops at Shildon, known as "Soho Works." Here he not only constructed locomotives for the S. & D. R., but also for other railways, whilst at the same time he was responsible for the whole of the locomotive supply, working and repairs on the former.

In Chapter XV. particulars and an illustration are given of the first locomotive for Russia. Amongst other illustrations of early Stockton & Darlington Railway are Hawthorn's four-wheeled engine "Swift," with intermediate crankshaft. This illustration is taken from Deghilage's French work Origine de la Locomotive, and shows the engine in a later and rebuilt form, which was considerably different from that of the original. Some of W. & A. Kitching's locomotives are also illustrated, and some interesting particulars are given of three of Hackworth's engines exported in 1838 to Nova Scotia, which were the earliest locomotives to work in British North America. One remained in service until 1882; it was afterwards purchased as a relic by the Baltimore & Ohio Ry., and exhibited by them at Chicago in 1893.

In Chapter XVI. we obtain some excellent and amusing character sketches of the first S. & D. R. engine drivers, amongst whom was Jemmy, elder brother of George Stephenson.

In 1840, Hackworth severed his connection with the S. & D. R., and henceforth devoted his whole attention to his private engineering business. In Chapter XVII., particulars are given of later locomotives and machinery built between 1840 and 1850, terminating with the famous 2-2-2 engine, the second "Sanspareil," which was the last locomotive built by Timothy Hackworth, and appeared at the end of 1849. Details are also given of stationary and colliery winding engines; one of the latter is still at work.

The longitudinal boiler seams of the "Sanspareil" were welded and the dome was also welded and flanged out of a single plate.

Chapter XIX. deals with the work of John Wesley Hackworth, the son of Timothy, and the inventor of the well-known radial valve gear, and in Chapter XX. the author adds a just appreciation of the work and characters of Richard Trevithick, George Stephenson and Timothy Hackworth. An appendix of twenty-seven pages contains extracts from a number of historical letters, and documents.

Kent's Mechanical Engineer's Pocketbook. Tenth Edition, 2247 pages, profusely illustrated. John Wiley & Sons, New York.

The tenth edition is much larger than the ninth edition which came out in 1916, there being a total of 2,247 pages as compared with 1,526 pages in the ninth edition, an increase of 721 pages or more than 47 per cent. The additional matter contained is about 50 per cent.

In the revised, rearrangement, and preparation of new matter, the Editor-in-Chief, Mr. Robert Thurston Kent was ably assisted by a staff of 35 among the best known engineers in the country, whose names will be found on pages 3 and 4 of the new edition.

Among the new subjects which appear in this edition is: Aeronautics, Automobiles, Heat Insulation, Reinforced Concrete, Safety Engineering and Machine Design, while other sections have been rewritten so as to be practically new.

In 1875, or some 48 years ago, the late William Kent began collecting data and preparing manuscript, based on his personal engineering experience, from which to make a text or pocketbook for engineers. The first edition appeared in 1895, and the name Kent has long been recognized as one of authority on the best engineering practice.

The underlying thought in the preparation of the new Kent was to save the time of the busy engineer. This has been done by the use of charts, tables and diagrams, wherever and whenever possible. For example, the designing engineer can obtain, in the new Kent, all the data necessary for the design of practically every commercial manufactured article; and these data are the very last word in every case. Thus it is a new Kent from cover to cover, and is all a modern handbook should be.

The paper, type, arrangement or sequence of subjects, and binding are all good.

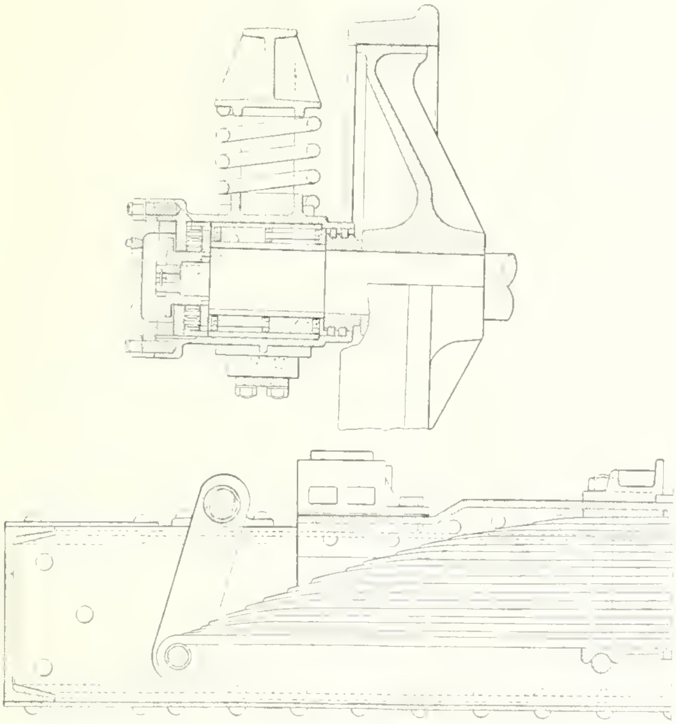
Electrification Data on the Chilean State Railways. The Westinghouse Electric & Manufacturing Company has just issued Vol. III., No. 3 of its Electrification Data Series, dealing with the Chilean State Railway Electrification. The booklet, which contains twenty pages and is amply illustrated with photographs and drawings, explains the problem that the Chilean Railway officials had to solve and how they solved it.

Foaming, Its Cause and Prevention. An instruction booklet of the foregoing title has been issued by the Bird-Archer Company, New York, and in simple terms explains how the Bird-Archer anti-foaming compound prevents foaming and gives instructions in regard to its use. Written for the benefit of locomotive firemen and engineers, copies for distribution to those so engaged will be furnished on request.

The detail of one-half of this spring and its hanger shows the construction. The side bearings are only 38 in. from center to center. The spring hanger has a drop of 9 in. and a spread of 2½ in. at each side, so that the angular resistance of the hanger to the swinging of the truck is more than that usually found on passenger cars, and will probably counteract the tendency of the truck to nose that might otherwise last.

The engraving of the cross section of the wheel and journal box which is fitted with the Stafford roller bearing that has already been described.

The foundation brake rigging on the truck is similar to that used on electric cars. There is an equalizer *I* to the center of which the pull rod from the brake cylinder levers and a compression rod *L* with turnbuckle adjust- the shoes to the driving wheels. There are no brake is attached. At each end there is a clevis attachment to the upper end of the live brake lever *K* which applies ments connects the bottom of the live lever with that of the dead, whose upper end is anchored to a bracket riveted to the transom.



Section at Journal Box and Half Elevation of Bolster Spring

The wheels are steel tired with a cast steel center and are 30 in. in diameter. The wheel base of the trucks is 5 ft. 2 in.

The light weight of the body complete with engine, transmission, generator, etc., is about 19,000 lbs. The weight of the trucks is 9,000 lbs., making a total of 28,000 lbs. The normal weight of baggage to be carried is 3,000 lbs. to which add that of 30 passengers at 150 lbs. each, the total loaded weight of the car will be about 35,500 lbs. or not as much as a heavy trolley car.

The car has not been at work for a sufficient length of time to determine accurately as to what the operation costs will be. It is, however, expected that it will make from 2½ to 3 miles on a gallon of gasoline, and that the expenses of running the train will not be in excess of fifty cents a mile.

Finally, one of the marked features and advantages of the car is that the transmission or any part of the propelling mechanism can be quickly removed and replaced by spare parts in case of necessity.

A "Never Stop" Railway

A new method of transit, known as the "never stop" railway is nearing completion at Southend-on-Sea, England, which, it is claimed, has remarkable possibilities in relieving passenger traffic congestion in large cities, according to the "English Mechanic and World of Science."

The system is the invention of Mr. W. Yorath Lewis, M.I.Mech.E., a well-known engineer, and his associates, and consists essentially in the use of traveling cars of a simple type, close together, which never stops, passing through stations at such a slow speed that anyone can step on or off, but shooting up instantly to a high speed between the stations. In this way the great loss of time in starting and stopping ordinary trains, whether electric or steam driven, it is claimed, is avoided—not only the time of the actual stoppage, but also the loss of acceleration immediately before and after.

The method was first described at the British Association meeting of 1911, but although a small experimental railway on these lines was erected at Ipswich, there has hitherto been no means of testing the idea on a practical scale. The equipment now under completion at Southend consists of two parallel tracks six feet apart, from center to center, and 300 yards long, one being the "up" line and the other the "down," joined together at each end in the form of a curve which is of no more than three feet radius. Between the rails is a large skeleton screw-thread or spiral arrangement constructed of a heavy central steel tube with spokes carrying a flat steel bar forming the spiral, the whole rotating at a constant speed and driven by an electric motor with suitable gearing at each end of the track. The driving screw comes to an end at the curves, but the cars are conveyed round and engage in the other spiral again by an arm arrangement driven by a worm wheel geared to the driving shafts.

The cars are roofed in but open at one side, each carrying eight people seated and four standing, running with rubber-shod wheels on the broad rails, and under the frame they engage with the rotating screw or spiral by means of a special projecting arm carrying two rollers. That is to say, as the long driving screw-thread revolves, in conjunction with the end driving mechanism, it conveys the cars along the track and continuously round the whole circuit. The system is so designed that though the screw-thread revolves at a constant speed, the pitch of the thread—that is, the distance between each of the spirals or teeth—is different. When, therefore, the car enters a portion of the screw where the teeth or spirals are close together it travels very slowly, but when the screw widens out again—that is, when the pitch increases—the car speeds up. The arrangement is such that the car never stops travelling, since the screw is continuously revolving at one speed, but by a suitable alteration in the pitch of the screw at intervals it slows down to 1½-3 miles per hour when passing through stations, and when clear of these shoots up at once to about 24 miles per hour. The passengers step in and out of the train without difficulty because of the slow speed, just as they do in the case of a moving staircase. The system includes a large number of cars on the track, each driven independently by the varying-pitch screw, and close together, so arranged that at any given time there is always a car passing through a station at slow speed one behind the other, which on leaving the station shoot apart again, but come together at the next station. The capacities claimed for the system are extraordinary, and on the installation at Southend it is stated that 1,800 passengers per hour can be carried either way.

Many criticisms suggest themselves to engineers, particularly the wear and tear on the driving spirals and the methods of stopping the entire series of cars.

Canadian National Mountain Type Locomotive

Heavy Passenger Traffic of Eastern Canada Requires Adoption of Mountain Type Locomotives

There has just been built at the Canadian Locomotive Company's works at Kingston, Ont., Canada, the fine and powerful Mountain or 4-8-2 type locomotive shown in the accompanying illustration, bearing the road number 6000. It is one of sixteen of same type now building, six of which will be put into service between Montreal and Toronto, 333 miles, and ten on the Atlantic region east of Moncton. These locomotives represent the latest development in Canadian design of high-speed passenger engine, and are the largest passenger engines in Canada, combining power with economy of running, the overall length of engine and tender being 90 ft.

A large number of the details used in their construction are of Canadian National standard design, and common to all of their large modern power. However, there are many new features necessarily introduced in the building of a new type with the dimensions and power of the Mountain type.

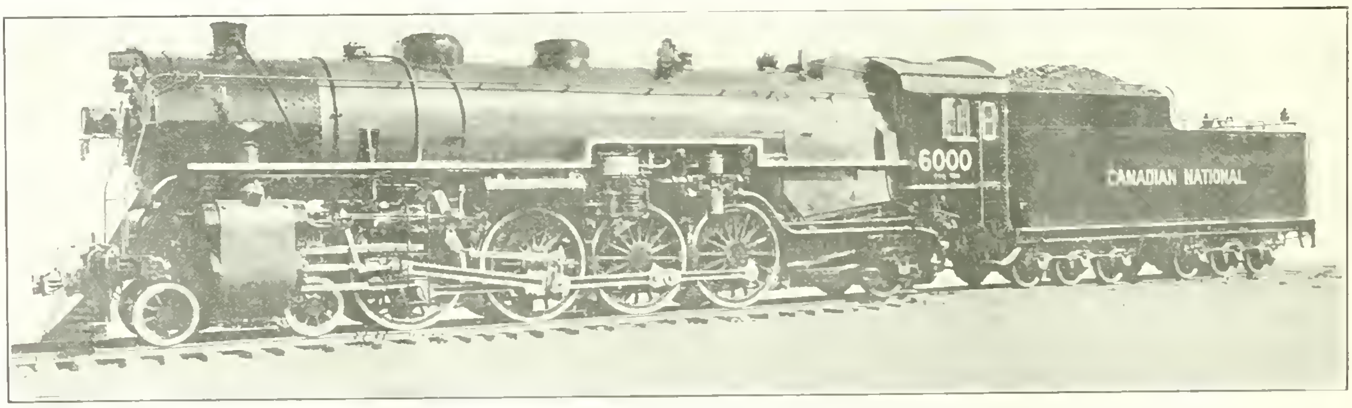
These locomotives are designated by the C. N. R. as the U-1-a class, road Nos. 6000 to 6015. They have a total weight, without tender of 339,000 lb., weight on the drivers being 226,770 lb. The tractive power is 49,600 lb., and the factor of adhesion is, therefore, 4.5. The cylinders are 26 in. diameter by 30 in. stroke; driving wheels 73 in. diameter, and boiler pressure 210 lb.

The boiler is of the straight top radial stayed type, with a conical bottom, the largest course being 90 in. in diameter. The firebox proper is 84¼ x 114⅛ in. inside and the combustion chamber is 48½ in. long. The boiler h.p., in per cent of cylinder h.p., is 96.4 per cent. There are 188-2¼ in. tubes and 40-5½ in. flues; 22¼ ft. long, the flues being electric welded into back tube sheet, as per Canadian national standard.

A feature of Canadian national practice in crown staying, which has been followed on these boilers, is the alternation of successive groups of four transverse rows of crown stays, i.e., four rows of button head crown stays are succeeded by four rows of plain heads and so on alternately. This arrangement provides against the possibility of a boiler explosion, in the event of a burnt crown sheet, by reason of the sheet giving first at a point where stayed with plain head stays, and pulling down over some of these stays, at the same time, being held on either side by the button head stays, the pressure being relieved through the holes where the sheet comes over the plain heads. In view of the size of these locomotives, and in order to take advantage of every means for efficient operation, they are equipped with mechanical stokers and feed water heaters, the boiler feed apparatus on the left hand side consisting of a pump, in connection with the feed water heater, and on the right hand side a Hancock type E. A. lifting injector of 3,500 gal. capacity. The grates are of C. N. R. standard design, the rocking grate bars being of cast steel, and operated by Franklin power grate shakers.

The superheater used is the Robinson, one of the standard superheaters in England, but comparatively new on Canadian roads. It embodies many interesting features, prominent among these being the maintaining of steam in the superheater units at all times, this being calculated to lengthen the life of the units.

The ash pans are of the Canadian National standard hopper type, the location of the door hinges being such that the doors close of their own weight. An attachment, which is the road's standard practice, and known as the ash pan sludge, is worthy of note. It consists of a 1¼ in. pipe from the delivery pipe of the inspirator to the ash pans, with valve operated from the cab, and a branch extending into each hopper. The arrangement is specially valuable, as it permits the direction of hot water into the pans to thaw them out, when the locomotives arrive at a terminal, in freezing weather, with pans partly filled.



Mountain or 4-8-2 Type Locomotive of the Canadian National Railways

Engine and Running Gear Details

The frames, with a single forward section are of carbon steel, thoroughly annealed, rigidly braced with cast steel crossties, and fitted with taper bolts throughout. The rear end is fitted with a Commonwealth cast steel cradle casting.

The equalizing system is of the usual type, the engine truck forming one system of equalization, while the four driving wheels on each side are equalized with the trailing truck, thus forming the other two systems, this arrangement giving a three-point suspension. The equalization places approximately 57,300 lb. on engine truck; 226,770 lb. on drivers and 54,930 lb. on trailing truck.

The driving wheels are 73 in. diameter, with 66 in. centers of cast steel. The axles are 10 in. diameter at journals, except main journals, which are 12 in. diameter, and, due to weight consideration and in keeping with modern practice, are hollow bored.

The driving boxes are of cast steel, with bronze bearings and the boxes at the front pair of drivers are the Franklin lateral motion type, designed to compensate for the long wheel base necessary on large modern engines when taking curves. Franklin adjustable driving box wedges, and Franklin hard grease cellars are used throughout. A comparatively new feature in connection with the driving boxes is the application of the Franklin driving box spreaders, a permanent casting fixed at the bottom of the box. It prevents any spring to the sides of the box, and makes the removal and repacking of grease cellars a very simple, as well as quick, operation.

The crosshead is fitted with the Rogatchoff adjustment, which permits the adjustment of the shoes to take up wear.

The crosshead guides and piston rods are of such length that the piston may be carried out clear of the front cylinder head, without disconnecting the piston rod from crosshead.

The engine truck is of the Commonwealth constant resistance 4-wheel type, equipped with Preston hub slip liners and Armstrong oilers. The wheels are 34¼ in. diameter, and have spoked steel centers 28 in. diameter, common to all Canadian national modern passenger engines. The trailing truck is also of the Commonwealth constant resistance and 36 in. cast steel wheel centers.

Steam distribution is provided for by Walschaerts valve gear, of modern design. The diameter of the piston valve used is 14 in., and the valve setting is as follows: Travel 6½ in.; lap 1⅛ in.; lead ¼ in.; exhaust clearance ¼ in.

The cylinders follow Canadian National standard design, being equipped with railway standard by-pass valves, and four standard cylinder cocks to each cylinder, two being placed at the center of barrel and connected with a drain pipe from bottom of steam chest, this pipe being covered by the cylinder jacket, the fourth cock being piped to the exhaust cavities which are drained from each quarter. All eight cylinder cocks are operated in unison, by one set of levers. The cylinders are also equipped with the railway standard relief valve. The bottom of the cylinder casting is arranged so that the engine truck center plate is checked into it, thereby affording ample provision to withstand the thrust which this part is subjected to.

Details of Cab and Piping Arrangement

The cab is of the standard short vestibule type, which makes it possible to have almost all the short stays in sides of firebox, out clear of cab, the few that remain inside all being F. B. C. flexibles.

Great care has been given to the piping layout, and, as far as practical, it was laid out in the drawing room, rather than waiting for the first engine, as has usually been the case. The cast steel turret, with eight outlets, has been placed outside 25 in. ahead of the cab, affording lots of room for packing the operating valves, which are all of one standard design, entering the turret horizontally from the rear, with the valve seats at the front of the turret, six of the steam connections from the turret being taken from the front, these connections being fitted with a coupling nut, and tail piece, tapped to suit the several pipe sizes, thereby permitting the use of one size standard operating valve. These operating valves are fitted with extension handles, carried into the cab and labeled. None of the valves are threaded into the turret, each one being secured with a cast steel flange, and four studs tapped into turret walls, bosses being provided inside turret, so that studs do not go all the way through. This eliminates any leaky threads in turret, as well as simplifying removal of the valves when necessary. Not only has the turret been placed outside the cab, but the inspirator, blower valves, and stoker engine valve, as well. This arrangement not only makes valves more accessible for packing, but removes the great danger of scalding, in case of a sideswipe, or similar accident, that would tend to burst steam pipes inside the cab.

The sand box is fitted with Hanlon sanders. Three World type safety valves are used, 1 muffled and 2 plain. The headlight equipment is made up a Pyle National type K-2 turbo generator set, and Keystone type 1412 cage, fitted with a 14 in. Golden Glow reflector and C. M. S. focussing device, the cage body being no. 16 gauge copper, and C. N. R. standard separate number lamp case with sides oblique, this making for the maximum safety in operation, by reason of the easier and more certain identification of locomotive numbers. The water level indication is procured by the most modern method and consists of the Canadian national standard water column, welded directly to back head of boiler and fitted with Canadian national standard try cocks and water glass fittings, the water glass being fitted with a special guard. The steam-heat reducing valve is of the World Leslie type, and the piston and valve rod packing is King Metallic. The Franklin radial buffer and Unit safety bar are used between engine and tender, and Barco flexible joints are used between engine and the tender on the steam heat line.

Following are the chief details of the locomotives:

Type	Mountain
Gauge	4 ft. 8½ in.
Type of cab	Vestibule
Fuel	Bituminous coal
Service	Passenger
Limiting height	15 ft. 3 in.
" width	10 ft. 8¾ in.
Weight in working order on drivers	226,770 lb.
" " " " " engine truck	57,300 lb.
" " " " " trailing truck	54,930 lb.
" " " " " total engine	339,000 lb.
" " " " " engine and tender	557,000 lb.
Wheelbase, rigid	19 ft. 6 in.
" engine	41 ft. 9 in.
" engine and tender	79 ft. 1¾ in.
Diameter of driving wheels	73 in.
Material of driving wheel centers	Cast steel
Leading truck wheels	34¼ in. diam.; 28 in. spoked steel centers
Trailing truck wheels	43 in. diam.; 36 in. cast steel centers
Diam. and length of main driving journals	12 x 13 in.
Diam. and length of other driving journals	10 x 13 in.
Diam. and length of engine truck journals	6½ x 12 in.
Diam. and length of trailing truck journals	9 x 14 in.
Boiler, type	Radial stayed, with combustion chamber
Boiler, outside diam. first ring	90 in.
Boiler, working pressure	210 lb. per sq. in.
Tubes, number and diameter	188; 2¼ in.
Flues, number and diameter	40; 5½ in.
Length of tubes	19 ft. 6 in.
Combustion chamber, length	48½ in.
Heating surface, firebox and arch tubes	348 sq. ft.
Heating surface, tubes and flues	3731 sq. ft.
Heating surface, total	4079 sq. ft.
Superheating surface	832 sq. ft.
Firebox length and width	114⅛ x 84¼ in.
Grate area	66.7 sq ft.
Valves, type	piston
Valve travel	6½ in.
Valves, diam.	14 in.
Valves, lap and lead	Lap 1⅛ in.; lead ¼ in.
Valves, exhaust lap or clearance	Clearance ¼ in.
Cylinders, stroke	30 in.
Cylinders, diam.	26 in.
Tractive effort	49,600 lb

Factor of adhesion 4.5
Boiler h. p. in % of cylinder h. p 96.4

The first of the locomotives No. 6,000 was turned out of the works on May 31, and was taken to Montreal, where it was on exhibition for a few days, after which it was placed on exhibition in Toronto, before being placed in regular service.

Tender Details

The tender tank is of the water bottom type of the road's standard design and construction, somewhat modified for the application of the Duplex mechanical stoker. The tank has a water capacity of 10,000 Imperial gallons and coal capacity of 17 tons The tender frame is of the Commonwealth cast steel type. Commonwealth six-wheel tender trucks are used, with 5½ x 10 journals. Flat side bearings are used, placed 52 in. apart both front and back.

The air brakes are Westinghouse No. 6 E. T., with 8½ in. cross compound compressor and S-5 governor. The pump is on the left side. There are three main reservoirs, 2 on right side and 1 on left side, with a total capacity of over 90,000 cu. in. The radiating pipe, connecting reservoirs and compressors, so arranged as not to be visible, and is supported by cast iron brackets under the running boards. This radiating feature has been of good service in overcoming condensation, and consequent freezing, in low temperatures. The air brake piping on these locomotives has been given very careful study, which has resulted in a layout that is easy of access and of a very neat appearance.

Transverse Fissures in Steel Rails

The Causes of Rail Breakages As Developed by the Bureau of Standards

The Interstate Commerce Commission has published a report on Transverse Fissures in Steel Rails by its engineer physicist, Mr. James E. Howard, showing the cause of a common method of rail failure, from which we publish the following abstract:

The term "transverse fissure applies to a type of fracture which has its origin in the interior of the head of a rail and which progressively enlarges from a definite nucleus. As the term implies, the plane of rupture is crosswise the length of the rail and substantially perpendicular to its axis.

One of the objects of the present report is to show how general this type of fracture has become in territory where congested traffic conditions prevail, affecting the trunk lines of the country, and furthermore, to point out that a stage is being reached in which the margin of strength of steel rails approaches a stage of exhaustion.

The nucleus of a fissure, a few hundredths of an inch in diameter, presents an appearance not unlike the tensile fracture of a test piece. A silvery crescent next forms, concentric with the nucleus, which later assumes an oval shape, surrounding the nucleus, and increasing in size until the periphery of the rail is reached. The surface of the fissure presents a silvery luster, which is maintained until air is admitted, whereupon it turns a dark color. Transverse fissures are found in different stages of development from a small silvery crescent up to a diameter of 2 or more inches, nearly separating the entire head of the rail.

The nuclei are commonly located in the upper part of the head, not far from the middle of its depth, and predominate on the gauge side. Some, however, are located centrally over the web, and a smaller number in the outer half of the head. Figure 1 indicates the locality where the majority of transverse fissures have their origin. Figure 2 shows the appearance of a fissure in an advanced stage of development.

Transverse fissures have an interior origin because the metal immediately below the running surface of the head is in a state of compression due to the cold-rolling effects of the wheels. The cold rolling introduces intense strains of compression in the zone of metal along the upper part of the head. Gagging and cooling may also introduce strains, but regardless of these the cold rolling action of the wheels is the predominating influence and the head of all rails normally acquire, a state of compression in the zone of metal adjacent to the running surface.

Strains of compression in the periphery are necessarily balanced by those of tension in the interior of the head. It is in this core of tensile metal that the nuclei of transverse fissures are located. When the intensity of the strains of tension become sufficient, or the number of repetitions of loads are great enough the rail ruptures by tension. The upper fibers being in compression are not the first to rupture. The metal simply fractures where it is in tension. Further the formation of independent transverse fissures in close proximity establishes the fact that cold-rolling strains and not bending strains were of paramount influence in their formation.

This feature has a bearing upon the use of rails of heavy sections. An increased section modulus, and consequent lowering the range of the outside fiber stresses, does not give immunity to a rail from this type of fracture. Increased weight of rail, which carries with it increased sectional area of head, does not materially modify the effect of the impinging pressure of the wheels. In fact, increased width of head may facilitate the acquisition of high internal strains along the central elements of the head, possibly promoting rather than retarding the formation of transverse fissures.

A general analysis covering more than 8,000 transverse fissures on 23 railroads show the number of transverse fissures to be greatest on those roads where the traffic is the heaviest. Analyzing the case a little further, it appears that transverse fissures occur in larger numbers on the gauge side of the head of the rail than over the web or in the outer half of the head. Furthermore, on curves the low rails display the larger number of fissures, while on double-track road the rails carrying the heavier traffic are most affected by transverse fissures. Extreme illustrations are found in which transverse fissures predominate in the tracks of heavier tonnage to their practical exclusion in other tracks.

The coning of the wheels concentrates the loads on the gauge side of the head. The superelevation of the high rail, to compensate for maximum speeds, influences the distribution of loads at lower rates of speeds on curves. The influence of these features is displayed in the formation of transverse fissures.

On the Harrisburg division of the Philadelphia & Reading Railroad the effect of congestion of traffic on one line of rails is conspicuously shown. Heavy freight movements on this division are in an eastward direction. Transverse fissures are in great preponderance in the east bound track. A partial enumeration shows 494 transverse fissures in rails in the eastbound track against 39 in the westbound track.

The influence of loaded freight cars is shown in this as well as in other examples, for the same locomotives in general pass over the freight tracks in each direction. The difference in weight of the loaded freight cars and their light weight constitutes the difference in the loading of these rails, and therefore appears as the responsible agency in the formation of the excess number of fissures in the east-bound freight tracks.

The relations between parallel roads may be such that a wide difference in the display of transverse fissures will

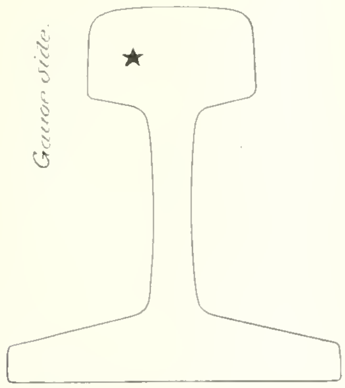


Fig. 1—Common Location of the Nucleus of a Transverse Fissure

result. For example the New York Central Railroad on the east bank of the Hudson River there were 263 transverse fissures as against 16 on the West Shore on the west bank. Again there were 262 transverse fissures reported on the Mohawk division of the New York Central against 17 on the Mohawk division of the West Shore.

As to the position in the ingot from which rails are rolled, it appears that whatever superiority may attach to a rail from a particular part of the ingot, marked superiority is not shown in the suppression of transverse fissures, according to the experience of the several roads.

The average ages of transverse fissures on different railroads in the main reflect traffic conditions. Weights of equipment, gross tonnage, and speeds are the prominent features which characterize the conditions on those roads where maximum numbers and minimum ages of fissured rails appear.

As to the effect of chemical composition; certain rails which displayed transverse fissures in large numbers on the Great Northern Railway were very hard rails in respect to chemical composition and were intended to offer great resistance against abrasion. It is understood that they have displayed the increased degree of resistance which was expected of them. After a time, however, transverse fissures appeared in numbers.

The use of very hard steel appears to account for the prevalence of transverse fissures in the rails of the Great Northern Railway, the experience of which is in accord with that of the other roads in the use of exceedingly hard steel.

It has been remarked by high authority that if certain premises were met, rails long in service would not only be likely to display transverse fissures, but would almost certainly do so. Such is the belief of the writer. Rails so situated are not commonly found, hence this predicted result is seldom reached. Possibly a few Bessemer rails which have displayed transverse fissures at ages ranging from 20 to 30 years belong to this class. Few open-hearth rails of great age are in service or so situated as to furnish information upon this feature.

There has come to notice one notable exception, furnished by some rails of 100 pounds weight rolled by the Bethlehem Steel Co. in the month of June, 1909. These rails have been in use in the tracks of the Pennsylvania Railroad for a period approaching 14 years. They have occupied a situation of exceptionally good maintenence, held by screw spikes, tie plated, supported on black gum or yellow pine or oak ties resting on stone ballast, and carried on a concrete base, but where heavy traffic prevails.

Rails of Bessemer steel which have displayed transverse fissures are few in numbers when compared with those which have occurred in open-hearth product. Structurally, examples of Bessemer rails have looked decidedly inferior to open-hearth rails. Preference has been given open-

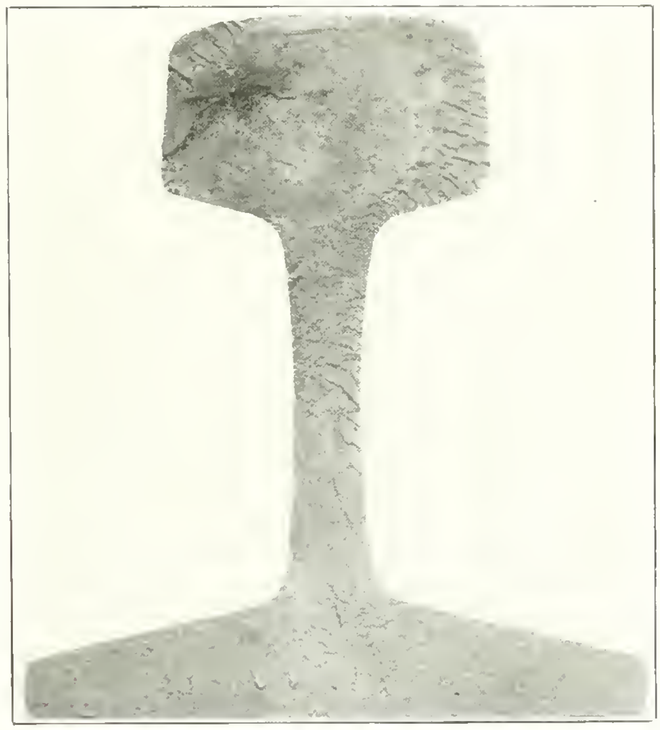


Fig. 2—Transverse Fissure in an Advanced Stage of Development

hearth metal by engineers; therefore, when it came to a consideration of transverse fissures, their comparatively absence in Bessemer rails seemed to throw an additional cloak of mystery over their formation.

The preceding remarks have related to the formation and display of transverse fissures as they have occurred in the track. Transverse fissures have also been produced experimentally by subjecting rails to treatment analogous to the cold-rolling action of wheels. The result was accomplished by repeated alternate overstraining the rail longitudinally. The facilities of the gagging press were made use of in applying the necessary stresses.

Half-length rails were used, applying gagging blows at short intervals along the length of the head, then reversing the bend and gagging the base in the same manner. This alternation of reverse bending was continued until ultimate rupture ensued.

By applying bending stresses at short intervals along both the head and the base the extreme fibers were overstrained practically the entire length of the rail. The outside fibers only were overstrained; those nearer the neutral axis were not strained up to their elastic limits. This treatment approaches the effects of the wheel pressures in affecting the surface metal and fibers remote from the neutral axis while not immediately affecting the metal nearer the neutral axis of the section.

A large number of gagging blows were required, each of which exceeded those employed in the ordinary straightening of rails. Proceeding in this manner, transverse fissures in 24 rails were formed. The number of gagging blows per full rail length ranged from 50,000 to 250,000.

The position of the inferior fissures was found controllable at will. Gagging the rail in upright position yielded a transverse fissure centrally over the web: inclining the rail to the right or to the left and applying the gagging blows in an oblique direction yielded transverse fissures located in the right or left side of the head, which ever way the rail was canted.

The accompanying illustration illustrates an experimentally formed transverse fissure, located centrally in the head. Others were formed in the right half and left half of the head respectively. These experimental fissures do not exhibit the highly lustrous silvery ovals of those which are formed in the track. They were accelerated results. Their formation was a tedious affair, however, which would have been much prolonged had lower bending stresses been used. The main result was achieved in producing transverse fissures at will, in accordance with the explanation of their formation.

Gagging in one plane does not produce a transverse fissure. It results in an ordinary fatigue fracture, having an exterior origin. Sixty-two rails were tested in this manner, each displaying the ordinary type of fatigue fracture. The number of gagging blows required to produce a fatigue fracture is so great that any anxiety concerning the few blows employed on the cold straightening of rails for service should be dispelled.

As to manufacturing effects, in general the condition of fabrication, as drastic as they sometimes appear, seldom affect the integrity of the steel.

Gagging modifies the arrangement of internal strains, and while it overstrains the outside fibers it has little or no influence on the inside fibers which are involved in the formation of transverse fissures. Furthermore, the principal effect of gagging is in one direction only—that is, longitudinally—whereas cooling strains in the head set up both longitudinally and crosswise strains. The influence of cooling strains in promoting the formation of split heads will not be overlooked.

Shattered zones have been found in some rails, located in the central part of the head and at the junction of the web and base. They have also been found in the base of the rail, but it has been learned that these zones did not extend to the hot sawed ends of the rails. The last circumstance fixed them as shrinkage or cooling cracks and the period of formation as being subsequent to the last pass in the rail mill.

Up to the present times these shattered zones have been found in the harder grades of steel, and not in those of medium hardness, according to their chemical composition.

These cracks without doubt indicate the relief by rupture of internal strains—those which were set up during cooling. Whether the cracks generally serve as the nuclei of transverse fissures still remains undetermined.

Internal strains acquired in service are located in the head of the rail, and are due to the cold-rolling action of the wheels on the running surface. The shallow zone of metal in the top of the head is affected by the intense impinging pressures between the treads of the wheels and the running surface of the rails. Internal strains of compression are set up in this zone, which not infrequently, in fact generally, exceed the direct bending stresses of the wheel loads. The internal strains constitute the most critical strains to which rails are exposed. It is not a matter of record that this aspect of the case has been given consideration either in the design of motive power and equipment or in their use.

To balance the strains of compression in the upper part of the head, the central portion acquires a state of tension. The strains of tension and those of compression maintain a state of equilibrium, any change in the magnitude of one being attended with a corresponding change in the other. Relief of compression by reason of the yielding of the tensile metal is temporary only. The cold-rolling action of the wheels is constantly going on and again builds up the compressive strains. This explains the formation of two transverse fissures in close proximity, a result physically impossible under the action of bending stresses alone.

In the harder rails but little distortion of the head occurs. Cold rolling strains accumulate in both longitudinal and crosswise directions. The longitudinal component leads to the formation of transverse fissures, the lateral component to the formation of a split head. In the harder rails, split heads occasionally appear in horizontal or slightly inclined planes. On the softer rails, split heads in vertical planes of rupture are those of common occurrence. A split head is liable to occur when lateral strains encounter a seamy streak in the steel. Mashed head rails denote a certain relief of internal strains occasioned by the lateral flow of the metal.

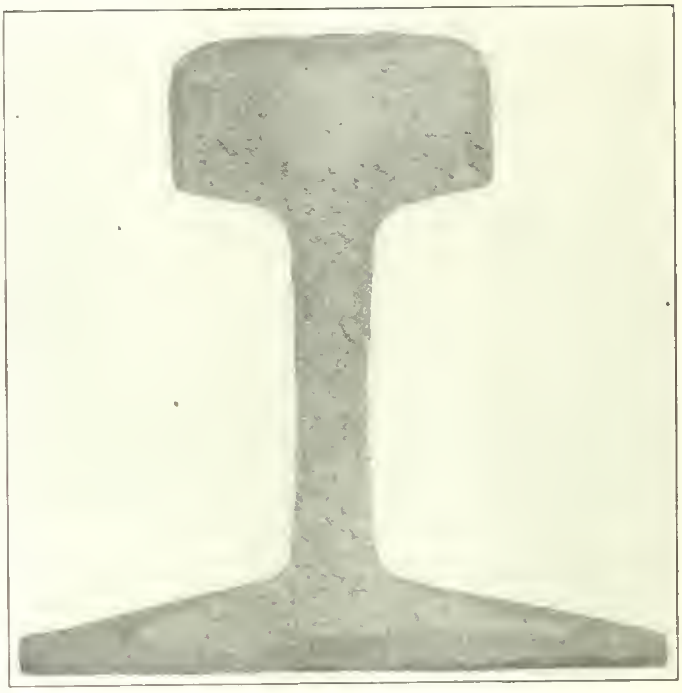


Fig. 3—Experimentally Formed Transverse Fissure. Located Centrally Over Web by Reason of Vertical Loading

Only a small portion of the peripheral surface of the rail is cold rolled. This accounts for the acquisition and disposition of the internal strains. If the entire cross section was cold rolled the rails would be extended in length and an impractical condition of maintenance presented. An engineering example of this kind has been exhibited in the use of rolled grips in street car cable transmission. The feasibility of the entire system of railway transportation, where loads are carried on wheels, depends upon the ability of the metal in the rails to endure internal strains of a certain degree. The acquisition of internal strains constitutes the salvation as well as the bane of the rail problem.

The normal result of cold rolling is the introduction of strains of compression in the top of the head. Examples present themselves in which tensile fractures are exhibited in this zone of metal, a result which is brought about by wheel burning. The skidding of wheels intensely heats the surface metal of the wheel tread and the top of the rail. The surface metal is over compressed to a greater degree than effected by the cold rolling of the wheels. Upon cooling, the strains at the surface are reversed and those of tension set up. Cooling by conductivity occurs very suddenly and a hardened veneer of surface metal results in which fine cracks are often formed. Instances have occurred in which a portion of the hardened surface metal was subsequently annealed, effecting the surface indications of wheel burning, but leaving a substratum of hardened metal below the immediate surface. In some cases the hardened metal flakes off; in other instances cracks which have been formed in the hardened steel continue their course into the normal metal below, culminating in the complete rupture of the rail.

The embrittling effect of wheel pressures has long been known. Regardless of primitive toughness of the steel, made the criterion in specifications governing the acceptance of rails, the initial toughness disappears under the cold-rolling action of the wheels.

An experimental demonstration was made in the introduction of internal strains in rails by cold rolling at the Sparrow's Point plant of the Bethlehem Steel Co., and service tests in the track of the Baltimore & Ohio Railroad and the Southern Pacific Co.

These tests furnished confirmatory results upon the introduction of internal strains in the heads of rails, in the zone of metal directly acted upon by the wheels, also showing their progressive character. Different depths of penetration appear to result from the effects of different wheel pressures.

At Sparrow's Point, three pressures were employed—15,000, 25,000 and 35,000 pounds, respectively. A chilled-iron wheel was used which traveled over a short length of rail with a reciprocating movement. The coning of the wheel concentrated the load on the gauge side of the top of the head.

Rails rolled on one side of the head acquired high internal strains on that side only. The internal strains were practically negligible on the opposite half. Reversing the rail, and rolling both sides, introduced internal strains on both sides. Rolling the rail on each side of the head with the lowest wheel load and then rerolling one side with the highest wheel load resulted in lowering the internal strains on the side rerolled. The alternating kneading of the metal at the top of the head lowered its capacity for retaining internal strains, but which doubtless permitted a greater depth of penetration of the effects of wheel pressures. A proportionality of strains would certainly be expected according to the magnitude of the wheel pressures.

Internal strains are acquired of varying degrees of intensity at different depths below the running surface. The volumn of this disturbed metal and its average intensity represents factors which influence the magnitude of the internal strains of tension, which counteract the direct effects of the wheel pressures.

Divergent views have been expressed on the subject of transverse fissures. In general, they have centered upon features involved in the fabrication of the rails. Their display has been attributed to initial defects in manufacture. Service conditions are regarded as the means whereby preexisting defects are made to appear and absolve the originators of rupture. Climatic or temperature conditions, however, are included among the influences which are alleged to facilitate their formation.

Broadly considered, three features constitute the rail problem:

(1) Girder strength.

(2) Abrasive resistance to the action of the wheels.

(3) Cold-rolling effect of the wheels on the head of the rail.

If the third feature was eliminated, there would be no rail problem, since the requirements of the first and second can be met without difficulty.

Internal strains of magnitude are introduced by the cold-rolling action of the wheels. They remain as permanent factors in the loading of the rails, even when no rolling stock is being carried by them. These internal strains not uncommonly exceed the direct track stresses. Cold-rolling strains of compression in the top of the head reach or exceed 20,000 pounds per square inch, the interior elements of the head acquiring a state of tension. The disposition of internal strains axiomatically explains why transverse fissures have interior origin.

The relation of cold-rolling strains to the formation of interior fissures not having been fully realized, confusion early arose and the discussion of transverse fissures was mingled with the subject of durability of steels.

Internal strains must be reckoned with. They are just as real as those caused by the presence of external forces. There is no recourse against their introduction. The fundamental feature of land transportation, carrying loads on wheels, involves their introduction. They were present in puddled-iron rails, used under light wheel loads where, indeed, the highest internal strains yet measured have been found.

It is questionable whether increased weight of rail, far beyond the heaviest now being rolled, would overcome their destructive effects.

Where the Dollar Goes on the Pennsylvania

Out of every dollar of revenues received by the Pennsylvania Railroad System last year, 51.4 cents—more than half—were immediately paid out in salaries and wages to the company's 200,000 employes. This is shown in a report just compiled setting forth how the Pennsylvania Railroad's "dollar" was spent in 1922.

Materials and supplies used in every day railroad operation took 17.07 cents out of every dollar earned. This was the second largest slice. Coal for the System's 7,547 locomotives took 7.29 cents. The consumption of these materials and supplies gave employment and business, and illustrates how the railroads contribute to the country's prosperity.

For the support of municipal, state, and federal governments, the Pennsylvania Railroad paid in taxes, in 1922, a total of 4.54 cents from every dollar.

Loss and damage payments, depreciation on rolling stock and other property, and miscellaneous rentals, absorbed an additional 6.41 cents of the railroad's "dollar."

After meeting operating expenses and taxes, 7.72 cents were needed to pay fixed charges, which include the interest on the funded debt.

Of the original "dollar" 5.56 cents finally remained to pay a return to the stockholders, and sustain the company's credit.

Swedish Locomotives for Argentina

The Railroad Board of Argentina has contracted with Nydquist & Holm A/B of Trollhatten, Sweden, for the construction of 50 locomotives, all but 1 or which are to be of the type used on Swedish railways. The other is to be a Ljungstrom turbine locomotive, which will be given a thorough test on long runs to determine its suitability before ordering more of that type.

Thermal Stresses in Steel Car Wheels

A Report of An Investigation by the Bureau of Standards

The Bureau of Standards has made an investigation into the stresses developed in steel car wheels by artificially heating the rim of the wheel by means of a resistance coil placed about the tread, in the same manner as that described in connection with the investigation of cast iron wheels as described in RAILWAY AND LOCOMOTIVE ENGINEERING for June, 1922.

In this investigation thirty-three steel wheels were tested from six different plants and representing five methods of manufacture in current use.

A part of the investigation included a research into the physical and chemical properties of the wheels under examination. An interesting feature of this lies in the slight variation of the wheels from each other, and the small range on either side of the general average. As the names of the manufacturers of the individual wheels are not disclosed the details of the results are given in the bulletin published by the Bureau are not given here in full but the range of values and the averages instead.

In the course of the investigation the coefficient of expansion was determined from specimens taken from one wheel of each manufacturer. These specimens were 30 centimeters (11.81 in.) and 1 centimeter (.39 in.) square. This determination was made for a range of from 20° to 400° centigrade which corresponds to from 68° to 752° Fahr. In the tables here given the temperatures as given are converted to the Fahrenheit equivalents.

Coefficients of Expansion of Six Steel Wheels from Different Manufacturers

Temperature Range Fahr.	Coefficient of Expansion Range	Average
32 to 122	.00055 to .00060	.00057
32 to 212	.00114 to .00125	.00118
32 to 302	.00177 to .00194	.00183
32 to 392	.00244 to .00267	.00251
32 to 482	.00314 to .00345	.00323
32 to 572	.00389 to .00427	.00399

The tensile properties of the six wheels showed a proportionally small range from the general averages, but still somewhat greater than the coefficients of expansion. These were as follows:

Tensile Properties of Steel Wheels

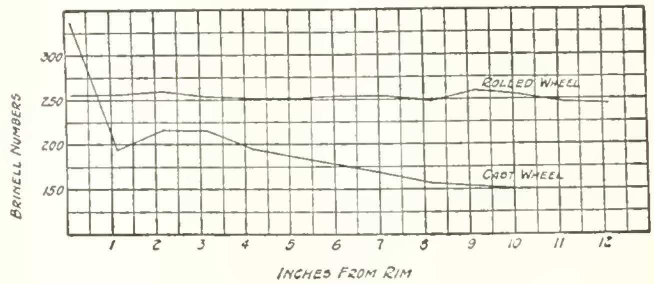
	Range		Average
Proportional Limit Lbs. per sq. in.	38,400 to	49,500	45,700
Yield Pound Lbs. per sq. in.	43,400 to	61,900	52,280
Ultimate strength Lbs. per sq. in.	85,000 to	130,200	114,500
Modulus of elasticity	28,900,000 to	30,500,000	24,433,333
Elongation in 2 in. per cent	11.2 to	14.5	12.8
Elongation in 8 in. per cent	7.9 to	10.5	9.0
Reduction of area per cent	10.5 to	23.6	15.1

When it comes to the chemical composition the ranges were greater still and, as far as the carbon is concerned, ran from a comparatively mild steel to one rather high. The range and average of the different impurities are given in the following table:

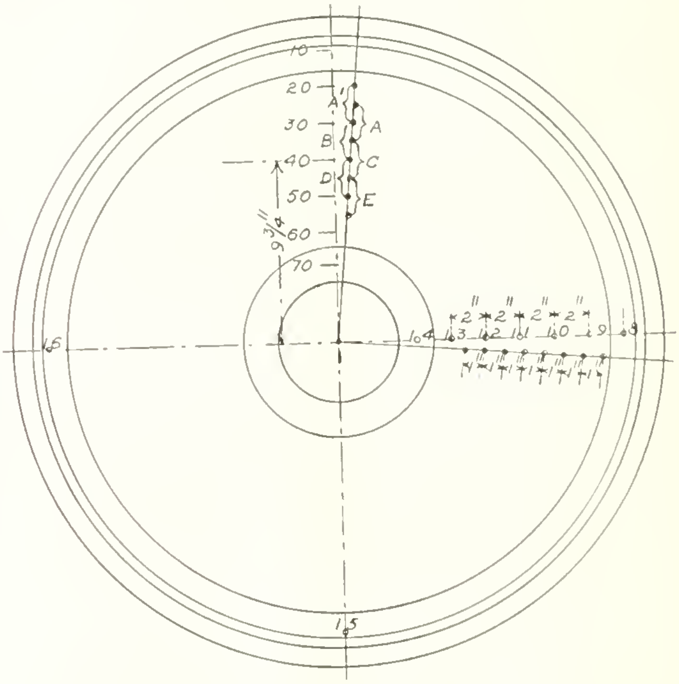
Chemical Composition of Steel Wheels

	Impurity Range	Average
Carbon, per cent	.25 to .77	.64
Sulphur, per cent	.014 to .032	.021
Phosphorus, per cent	.019 to .032	.026
Manganese, per cent	.66 to .77	.71
Silicon, per cent	.16 to .28	.21

A survey of the radial sections of the rolled and cast type of wheel was also made for Brinnell hardness. Impressions were made at 1 in. intervals along the radius, the first one being about ⅛ in. from the tread. There was very little variation in hardness along the radial section of the rolled wheels, but, for the cast wheel, the hardness varied widely from rim to hub. These wheels were hardest near the rim and softer in towards the hub, with a position quite deficient in hardness at the middle of the rim where shrinkage holes occurred. The accompanying diagram shows the variation in hardness from the rim towards the hub for the rolled and cast wheels. These curves were obtained from surveys made on two rolled and one cast wheel.



Variations in Brinell Hardness From the Rim Towards the Hub for Rolled and Cast Steel Wheels



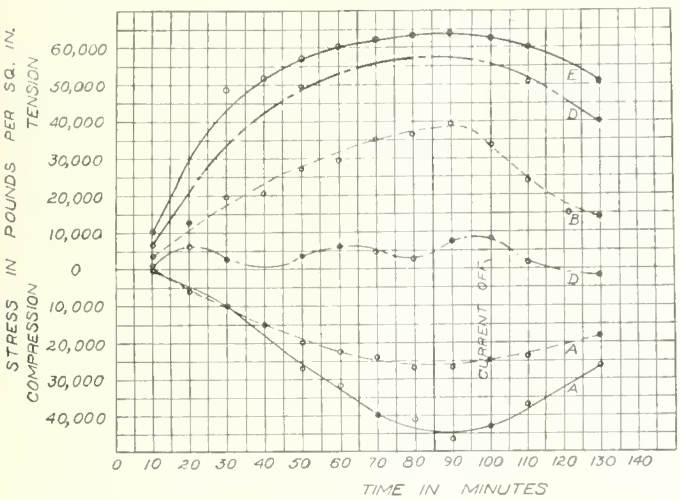
Locations of Thermo-Couple and Strain Gauge Holes

In making the thermal tests the average maximum temperature difference between the thermo couples that were placed in the rim and the hub was 552° Fahr.

As was predicted by representatives of the steel wheel manufacturers, none of the wheels tested failed from the stresses developed during the tests.

For the new rolled steel wheels of regular design the maximum stresses developed on the face of the plate were in tension near the hub and in compression near the rim, while on the back of the plate the conditions were reversed. These stresses are produced by expansion of the rim, causing the hub to move relatively to the rim in a direction towards the front of the wheel. The movement of the standard design wheels submitted by the various manufacturers varied from .07 in. to .10 in.

The accompanying diagram gives the stress-time curves



Typical Stress-Time Curves Showing Average Stresses on Face of Steel Wheels

of a wheel which may be taken as typical of the rest. The maximum stress was here obtained in 90 minutes, when the current was cut off from the resistance coil and the wheel began to cool.

According to this diagram the maximum stress was about 63,000 lbs. and was developed in the plate between the couples *B*, the inner one of which was located 9¾ in. from the center of the hub.

In these tests the rims of the wheels were heated electrically, and the hubs were kept cool by passing tap water through the hollow axle upon which the wheels were mounted. The maximum tread temperature was about 515° in the regular tests and in the special tests a maximum temperature of about 930° was attained.

The interesting features revealed in these tests may be summarized as follows:

1. None of the wheels failed.

2. When the rim is heated, the hub moves with respect to the rim, including stresses in the plate which, for the first test on new wheels, are in tension near the hub and in compression near the rim on the face, while on the back of the plate the stresses for the same positions near hub and rim are about equal in magnitude but reverse in nature to those on the face.

3. The maximum stresses were slightly above the yield point of the material as determined in tensile tests.

4. A permanent set was apparent only for new wheels on the first test. For old wheels and succeeding tests on new wheels there was no set apparent, showing that the stresses above the yield point were not increased by repeated heating, and that the old wheels had been rendered, by service, in a condition similar to that of new wheels after the first thermal test.

5. For forged wheels the character and magnitude of the stresses developed in the surface of the plate are little affected by the method of manufacture. The stresses developed in the cast-steel wheels were, because of the corrugated plate, more complicated than those in the rolled wheels.

Heating Effect of the Thermal Test

Temperatures Developed in Cast Iron Wheels at Different Time Intervals

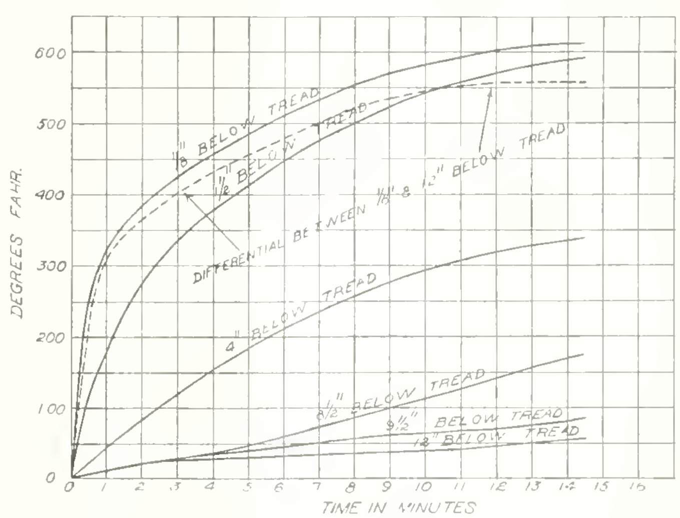
A great deal of light has been thrown on the effect of heating car wheels by brakes and a resistance coil by the investigations of the University of Illinois and the Bureau of Standards. The accompanying diagram illustrates another phase of the convection of heat from the rim towards the hub by the application of the thermal test which is a preliminary to the acceptance of cast iron wheels by the railroads.

The specifications require that the wheel shall be able to withstand the effects of the encircling band of molten iron for a period of two minutes. This requirement will be seen to check very closely and on the side of safety with the results obtained at the Bureau of Standards where the wheels were treated similarly, but by a resistance band instead of a band of molten metal. At the Bureau of Standards a difference of 300 deg. Fahr. between the temperature of the rim and the hub showed that some wheels were liable to crack.

According to this diagram, the temperature of the rim rises about 384 deg. in two minutes, and that of the hub 20 deg., leaving a differential of 364 deg. which the wheel must sustain without cracking.

After the two-minute interval, or, according to the diagram, when a differential of 364 deg. has been exceeded, the wheel may crack without involving the rejection of the wheels represented by the test.

The differential increases most rapidly, as would be expected, during the first half minute of the test when it rises on an almost straight line and becomes 243 deg. There is then a falling off in the rate of rise of rim tem-



Approximate Temperatures Developed in a Chilled Iron Wheel by the M. C. B. Thermal Test perature, while that of the hub, 12 in. below the tread, continues to rise slowly and at an almost even rate.

According to the diagram the differentials are as follows:

At the end of	Differential	At the end of	Differential
0 min. 30 sec.	243°	8 min. 0 sec.	520°
1 " 0 "	313°	8 " 30 "	529°
1 " 30 "	341°	9 " 0 "	535°
2 " 0 "	364°	9 " 30 "	540°
2 " 30 "	380°	10 " 0 "	544°
3 " 0 "	401°	10 " 30 "	548°
3 " 30 "	417°	11 " 0 "	552°
4 " 0 "	432°	11 " 30 "	555°
4 " 30 "	444°	12 " 0 "	557°
5 " 0 "	457°	12 " 30 "	559°
5 " 30 "	469°	13 " 0 "	558°
6 " 0 "	480°	13 " 30 "	558°
6 " 30 "	491°	14 " 0 "	558°
7 " 0 "	501°	14 " 30 "	558°
7 min. 30 sec.	511°		

This shows that after a lapse of 13 minutes the differential ceases to rise, and runs in a horizontal line showing that the absorption of heat from the band of heated metal and the convection of the heat to the hub is at the same rate.

If we take the average of the differentials of the sixteen wheels that were cracked in the tests of the Bureau of Standards tests we find it to be 407 deg. Fahr., or only 43 deg. above that at which the car wheel specifications require that it shall not crack, on the basis of this diagram. The range of these differentials was from 289 deg. to 473 deg., while the range of differentials of the wheels that did not crack ran from 405 deg. to 509 deg. All of which shows the wide range in the capacity of cast iron wheels to resist stresses developed by differences in temperature between the rim and the hub.

The Traveling Engineers' Convention

The thirty-first annual convention of the Traveling Engineers Association will be held at the Hotel Sherman, Chicago, Illinois, September 11-14 inclusive. The committee reports and subjects for discussion include:

Treatment of Feed Water for Locomotive Use, and Results of the Same.

What Advantage and Economy in Running Locomotives Over Two or More Divisions.

Automatic Train Control and Devices.

How Can the Work of the Traveling Engineer Be Made More Effective, and Can the Usual Number of Traveling Engineers Properly Take Care of the Duties Expected of Them?

Universal Brake Control Compared with Other Types of Brakes.

Advantages of Oil as Fuel for Locomotives.

Locomotive Feed Water Heaters.

A report with extracts of the papers referred to above together with an abstract of the discussions of them will be published in our issue for October.

France Adopts the Westinghouse Brake

The Superior Council of Railways of France has ratified the decision of a special commission appointed by the Ministry of Public Works adopting the Westinghouse air brake as the standard for French railways. The special commission tested three brakes, viz., the Westinghouse, the Lipkowski and the Clayton-Hardy vacuum. It is now proposed that the French Minister of Foreign Affairs should call a meeting of representatives of the allied countries in accordance with the Peace Treaty with the view of standardizing air brakes in continental Europe. The choice of the Westinghouse brake is said not to involve its exclusive use, but that any other similar pressure brake, capable of being operated with the Westinghouse might be allowed.

To Investigate Eyesight Conditions

A nation-wide survey of eyesight conditions in American education and industry has been undertaken by the Eye Sight Conservation Council of America, it is announced at the national headquarters of the Council in New York.

As to industry, the aim of the survey, according to Guy A. Henry, General Director of the Council, is to disclose the relation between defective vision and the efficiency of the nation's millions of workers. As to education, it is purposed to ascertain what steps have been taken by the schools to measure the extent of poor eye sight and to make effective preventative provision.

The Eye Sight Conservation Council's survey, marking the start of the research program recently adopted by the Board of Directors, has set out to reveal the effect of incorrect vision upon production. It has prepared a questionnaire designed to show increase in individual performance, decrease in accidents, increase in production and decrease in spoilage. The extent of color blindness, the number of blind in one eye, the number totally blinded, hours lost due to eye accidents, equivalent wages for lost time, use of goggles, cost of eye protection service, and total number of eye injuries are other objectives.

This questionnaire has been sent out to the industrial and commercial establishments located in the principal cities of the country.

The Council will also endeavor to show "to what extent is any effort being made to place in suitable jobs those workers who have been permanently or temporarily disabled because of eye injuries," and whether any attempt is being made to carry out the National Safety Code for the Protection of the Head and Eyes of Industrial Workers as prepared by the U. S. Bureau of Standards.

High Spots of Railroad Service

For a little more than three cents, or scarcely more than the price of a daily newspaper, the railroads carry a passenger one mile, along with baggage not exceeding 150 pounds. Approximately 9,000 pounds of vehicular equipment is necessary to make the passenger's ride comfortable.

For about one and one-tenth cents the railroads carry an average ton of freight one mile. To move the ton of freight requires an average of 1,700 pounds of car.

The Class I railroads in 1922 carried 339,730,198,000 tons of revenue freight a distance of one mile. This is equivalent to carrying one ton of freight a distance of 3,088 miles, or from Philadelphia to Los Angeles, for every man, woman and child in the United States.

Approximately 56 cents of each dollar paid out by the railroads in operating expenses went to employees in the form of wages in 1922.

To pay the average railroad employee's annual wage—which last year was $1,622—it was necessary for the railroads to haul one ton of freight 137,925 miles, or more than 45 times across the American continent.

Physical Statistics and Economic Operation*

By William H. Williams, Chairman of the Board, Wabash Railway

We have in railroading, as in every other industry, two classes of statistics. There are financial statistics—which may be said to be the language of the accounting and treasury departments and largely of the executive department, and we have physical statistics—which may be said to be the language of transportation and maintenance departments. The financial results no more than measure the amount of profit of the institutions; they do not measure the efficiency of the men in the various departments. The financial results, when compared with those of like understandings measure the relative value of the securities as investments; they afford some test of the wisdom of those who conceived the enterprise, whether they made a wise location for their railroads, had the capacity to select and develop men and whether they exercised sound judgment in making capital expenditures. All those things enter into the cost of securing money; that is, the amount that the corporation has to pay for it. But the responsibility for the location of that railroad rests with men who are now dead and gone. And so, as I said before, financial statistics do not today measure the capacity of the present management nor of the present operating staff.

When you come to track, there are four important elements—possibly five—but rail, ties, ballast and drainage are the four important factors in maintaining your track. The financial statistics do not indicate whether or not the track has been maintained. They indicate the expenditures, but they do not indicate what has happened to the property. If you look at the physical statistics you can get some intelligent view of the situation.

What is the number of miles of main track on each division that are maintained with new rail, and what is the weight of the rail? What is the number of miles of track laid with new rail each year for 15 years, and the weight of the rail laid? What is the density of traffic each year? Similar information ought to be secured for the tracks on each division. I make that suggestion because you may be buying sufficient rail to properly maintain the track in its entirety and yet, through failure properly to apply it, you may be improving the situation on one section of the line and letting another division deteriorate, a result that sooner or later adversely affects your traffic. Similar information ought to be secured for each class of track on each division where relayer rail is used.

When you come to the study of ties, there is the question of the number in main tracks, the number in passing tracks, and the number in sidings on each division; the number of each kind of tie, whether hard wood, soft wood, treated, soft wood untreated, etc., and the number that have been laid each year for 15 years. The study of that, together with the prices, will give you some indication of which is the most economical, and whether the present practice is the proper practice.

Of course, a comparison of the number laid with the total mileage of track ought to be considered. You can make similar analysis as to interlockers, on the basis of the number of levers to be maintained, and you can likewise take up other matters which come under the roadway and structures department. But that analysis, particularly with reference to ties, ought to be made for each operating division, for each supervisor's subdivision and for each track foreman's section.

Where the data are not collected in that way, the man who makes the most noise usually gets the most material and is the most wasteful.

When we go into the shop department, we take up, first, say, the locomotives. You have three general classes of locomotives—passenger, freight and switching—and you have different types and sizes of locomotives. You can today buy locomotives on the basis of weight.

In analyzing shop performance on locomotives, the first step is to ascertain the number of engines each kind receiving each class of repairs by months, namely, class 1, 2, 3, 4 and 5 repairs, for the past five years, making due allowance for the engines that are scrapped, sold, or withdrawn from service, including in that all engines not making mileage for three months; also making allowance for additions to locomotive stock. Then there should be a statement of engines out of service and not undergoing repairs during the preceding three months, those that are withdrawn and placed in white lead awaiting an increase in traffic and those withdrawn and intended to be scrapped.

For the engines that are repaired, there should be a statement drawn up showing the number, the service to which assigned, the size, the place at which the repairs were made, the class of repairs; also, the shop at which and the date on which the engine previously received class repairs. This statement should also show the average mileage between the former shopping class 1, 2 or 3 repairs, and the present shopping. The purpose of all this is to measure the efficiency of the repair work as it is being done.

By such analysis one railway found that the locomotives from one of its shops, averaged 56,000 miles between shopping, while the locomotives from its main shop on the system, where they naturally expected the best performance, were averaging only 18,000 miles. A study of that situation developed that the roundhouse people were paying little attention to engines out of the main shop, with the result that when they did get around to making any repairs, these engines have gone so far as to limit the mileage which could be made between shoppings, reducing it from about 56,000 miles to 18,000.

In addition to what I have already suggested, we should ascertain the number of man-hours at each shop on each class of repairs to locomotives, so as to measure the number of man-hours that are being worked on each class of repairs. That will give some idea as to the way in which the men are being handled.

When we take up the question of freight cars, we ought to have an analysis made of repairs to each class of freight cars, and separated as between all-steel cars, steel underframe cars and wooden cars.

Were I to criticise the present classification of operating expense accounts, I would direct most attention to repairs to locomotives and repairs to cars.

Repairs to cars are divided into two classes—repairs to freight cars and repairs to passenger cars. Repairs to locomotives are reported merely as "repairs to locomotives." Yet, think of the immense amount of money that is being spent in those three items, and the only information given is the total amount expended for repairs; and think of the very small amount of money that is covered by other accounts that are set up in the classification of accounts.

*Address before the 35th annual meeting of the Railway Accounting Officers Association at Richmond, Va.

There is no analysis made in the Interstate Commerce Commission's classification of repairs to locomotives or repairs to cars that is useful to the management of any company in the economical operation of the property, and a further study of these accounts ought to be made. For example, in connection with your car repairs, the information should be classified to show for each of the type of cars: (a) the number of end sills supplied, (b) the number of side sills, (c) the number of center sills, (d) the number of sides renewed, (e) the number of ends renewed, (f) the number of roofs renewed, (g) the number of wheels renewed, and similar information covering trucks, draft gear, coupler, air hose, etc. To the extent that we are using specialties we ought to give consideration to the kinds that are renewed, the dates, and the numbers purchased.

A few years ago I was asked to make an analysis of the coupler situation on the road, and I was told that a particular coupler was giving great satisfaction, that the number of breakages in relation to the number purchased was almost nil, while there was considerable breakage in the case of the Janney couplers. When I asked for a statement of the number of couplers purchased over a given period, I found that no Janney couplers have been purchased in eight years, and that the particular coupler which was reported to be giving such a good performance has been in existence for the previous two years only. Unless you get such elements in their proper relation you may get very far away from a proper conclusion.

In freight cars, we ought to show the number out of service undergoing repairs, the number out of service awaiting repairs, the number awaiting repairs one month or less and the number awaiting repairs over one month. That ought to be done for locomotives, too.

In the past mechanical departments have, in a measure, determined the policies of the companies with regard to equipment, before submitting the matter to the executives. They have failed to report certain types or classes of locomotives or cars until they had gotten in a condition requiring so great expenditures of money as to make their withdrawal from service the only economical thing which could be done.

And yet, if you say to the superintendent of motive power, "We will withdraw from service a given type of car at any time that it requires repairs equal to $150 per car, but will keep the repair up and keep the car in service until it requires $150 for repairs" you will practically never withdraw those cars from service! It is only through failure to keep up repairs that they allow the equipment to get into such condition as to require $600 to $800 worth of repairs per car, which leaves the management no option except to withdraw the car from service. And yet, generally speaking, I have never seen an accounting department join hands with the management of any company on the situation I have just outlined and get that remedy at any time adopted on any of the roads of the United States.

In connection with your freight car reports, analysis should be made of the M. C. B. repair bills, to ascertain the number of days that your cars are off the home line and on each foreign line, and the amount of the repair bills of each foreign line against your line.

Dividing the cars days into this bill will give you the average cost per day for repairs to your cars on each foreign line. Reverse that operation and ascertain the number of days that cars from each foreign line are on your line, and the amount of repair bills for a year are made against each of those foreign lines, and you will ascertain the average daily amount of your repair bill against each of the other lines. This will point out the roads where an investigation of the car repair bills will be worth while. We can make analysis in the same way for passenger cars, but I do not feel that it is necessary to go into details, as a similar practice can be followed.

Coming down to the transportation department, the capacity of the track is measured in trains. Trains must be spaced five to 10 minutes apart. As the speed varies the capacity is reduced. It is quite important, therefore, that we handle on each train its full tonnage capacity, because additions to the number of trains necessitate additions to the track capacity, and, of course, beyond that the tonnage that is handled on a train measures the profit that is received from its operation.

Your train is made up of locomotives and cars. You can equate the changes in size of locomotives by the thousands of pounds of tractive power. As you go over your cars there is the question of capacity, and the question is presented of the capacity that is utilized in handling a particular class of traffic; and, also, as to each class of traffic, the extent to which the shipper loads that car to its weight or cubic-content carrying capacity.

The importance of that is illustrated in this way: Your engine is hauling the dead weight of the car, it is hauling the paying load, and, in addition to that, there is the frictional resistance of each car that is handled. On a three-tenths per cent grade, the frictional resistance would be about 15 tons. So you are handling two constants—the dead weight and the frictional resistance. The paying load is variable. As you increase the paying load up to the capacity of the car, you are very materially increasing the percentage of the car, you are very materially increasing the percentage amount of the paying load in the train which one engine can haul.

On one road where an analysis was made recently, the falling off in 1922 as compared with 1920—and I will say that in 1920 we still had the benefit of the co-operation of the shippers which came during the war, when we got the best loading—was such that it required 10 per cent more engines, 10 per cent more cars and 10 per cent more fuel to handle the same tonnage that was handled in 1920. It is just a question of loading the car to complete capacity.

Yet, I should like to ask how many accounting men bring that matter to the attention of the managements of their companies?

Now, in addition to loading, the economical use of cars is dependent on mileage. To some extent loading is controlled by the tariff provisions as to minimum carload weights, and also by the shipper and consignee. An analysis ought to be made to determine which shippers are persistent abusers of the use of cars from a railroad standpoint, ascertaining the number of cars in each class which have been delayed unduly in loading or unloading. Also, each yardmaster should prepare a statement showing separately northbound and southbound cars, the number in yard six hours or less, the number in yard over six and not over 12 hours, the number in yard over 12 hours and not over 18, the number in yard over 18 hours and not over 24, the number in yard over one day. An analysis of that kind will indicate the yards which are having sluggish movements. Furthermore, it is a psychological fact that within six weeks of the time of putting that character of report into effect, the average delay in the yards will be cut in two.

When it comes to locomotives, we have the tractive power, and can equate the difference in sizes of the locomotives, using so many pounds of tractive power as giving the capacity of one. The haul is measured by the tractive power. Then you have the tonnage rating, and you have to make allowance for friction, as I have outlined above, and you have a reduction to make for speed and for temperature, high winds, etc. In the quick dispatch of perishable freight, you usually cut down the tonnage of the locomotive 20 to 40 per cent.

After giving consideration to those factors, the question is how near are you to securing 100 per cent from your locomotives on each division and on each set of runs. In connection with this comes the question of turning at the terminals and the number of man-hours per locomotive turned. Prior to the strike it took about 5½ hours to turn a locomotive; subsequently, it required about 8 hours, which meant a loss on the average of two and one-half hours on each locomotive every time it reached a terminal. I believe we are getting back to normal, but it is quite important to know the average time it takes a locomotive, because it has a material effect on the mileage.

There has come into vogue recently the practice of running an engine through two or more engine terminals. I was on one road recently where a passenger locomotive hauled the train 493 miles without change. The crews were changed en route. That was a coal-burning locomotive. Some other roads are running engines in freight service 400 miles, but they are using oil. That clearly demonstrates that the locomotive is a machine that can be run 400 or 500 miles without receiving the attention incident to turning in a roundhouse. It may have to stop en route to clean its fires, if it is a coal-burning locomotive. We have gotten into the practice of 100 mile terminals simply through force of habit. We are now going around making experiments in another direction which, it seems to me, will add very materially to the use of locomotives, having in mind that every time you turn a locomotive you are losing not less than five and one-half hours, and about a ton and a half of coal.

When you come to the traffic department, how many accounting men have made any analysis that is really worth while to that department, or to the management, in determining whether the road is gaining or losing?

You have the local business coming from the stations on your own line; as to that it is rather easy to learn in a general way from the loading statements, whether you are gaining or losing, and to point out the class of traffic in which the gain or loss occurs. In the same way, why cannot you take the interline reports and analyze them to show the amount of traffic coming from different railroads of the United States or destined to those various railroads, both with respect to the volume and the class of traffic and how it compares with other years over a given period?

We have statements of the gross tons that are handled, the tons handled one mile of the traffic loaded locally and of the traffic received in interchange. But the interchange is unclassified. There is no analysis except as to the immediate connections. There is no analysis showing where that traffic originates, or where it is destined, or to what extent we are getting out of the situation what there is in it.

We might analyze the O. S. & D. reports to see the extent to which reports are made against each station for loading—local and foreign. That will point out the places where there is carelessness in loading cars. That can be supplemented by having photographs taken as the car is broken open at the destination station, or at the place where the damage is located.

We ought also to make an analysis of the increase or decrease in material costs which is due to the number of units of material and to make a similar analysis of the increase or decrease in material costs due to the number of man-hours in each class of work, and we ought to show wages as divided between the regular and the extra allowances, and analyze the extra allowances.

Generally speaking, in making our comparisons, we make them with the preceding month and with the corresponding month of the preceding year. It is seldom that we find that our statistics extend over a sufficient period of time to indicate the trend. The important question is—are we gaining or are we losing? We should undertake to state our statistics for 10-year periods. That gives us something which will enable every man to see the direction in which we are going.

Take, for example, locomotives: Make an analysis of the aggregate and average tractive power of your locomotives in freight and in passenger service as compared with the aggregate and average tractive power 10 years ago or 20 years ago. Has the increase in freight train loading kept pace with the increase in the average tractive power of freight locomotives? Has the loading of freight cars of each class increased correspondingly with the increase in capacity of each class of freight cars?

A statement should be made of the earnings of cars by classes. It need not be exact, but it should be approximately so. What are the earnings per year of box or refrigerator cars, of open top cars, of flat cars and of stock cars, etc.? I have had an analysis of that kind made on a number of roads. Generally speaking, it has resulted in the purchase of cars of a different type from that first recommended by the operating department.

Further, an analysis should be made of the reports of the car service department on the shortages of cars at each point on the line. Is it a seasonal shortage; is it one that goes on throughout the year, and for what type of car and what class of traffic?

Generally speaking, when we undertake to buy cars, we look at our per diem balances and give consideration to buying enough cars to offset the per diem balances. But we ought to take into account the loss of traffic that is due to the failure to furnish cars to supply the reasonable demand throughout the year.

I do not know how far these thoughts have interested you. I have endeavored to present them as suggesting or indicating some of the variable factors in the different departments of railroading, in the hope that you will endeavor to understand the problems of those departments and to speak their language, which will bring about that mutual confidence that is essential to successful operations.

Honorary Memberships

The American Welding Society

At the annual meeting of the American Welding Society in 1921, by unanimous vote of the full board of directors, honorary membership, for noted achievement in the art, was conferred on Prof. Comfort Avery Adams, Dr. Elihu Thomson, and Monsieur Edward Fouche, of Paris, France.

The honor is evidenced by a handsome gold badge or emblem and a beautifully engraved diploma to each recipient. In the latter, the particular branch of the art in which the recipient is most distinguished is specifically mentioned. The emblems and diplomas have been presented to Prof. Adams and Dr. Elihu Thomson, while Judge Walter Berry, President of the American Chamber of Commerce in Paris, France, has through personal acquaintance with one of the committee, very kindly consented to make the presentation to Monsieur Edward Fouche at a formal function in the American Chamber of Commerce rooms.

The engineering profession both in France and America is under additional obligation to Judge Berry for his public spirited action in this matter.

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Industrial Education

For several years we have been hearing a great deal about what is called Industrial training in the public schools, but the matter makes very little real progress. The most hopeful phase of industrial training to-day is what many railroad companies are giving their mechanical apprentices through schools connected with the different machine repair shops. The young men who attend make excellent progress in the knowledge of applied mechanics. The larger railway systems are performing this service for the country at large and others are promising to perform similar public service in the near future.

This is performing the duty which our educational authorities ought to carry on, and it is to be hoped that they will soon wake up to the necessity of putting technical education within the reach of workmen. However high the intellectual development of a community, however extensive their educational standing, there must be a large majority of its individual members, artisans and common workmen. It is the proper education of this class that public schools and educators should direct their attention. The ordinary boy with a school education who enters a machine shop to make his living is an excellent subject to improve by education concerning his business. The duty of imparting special education might not to be left to railroad companies alone or to the more enterprising class of manufacturers.

We know that the assumption is frequently made that men working in mechanical industries are interested in technical literature only as far as it applies to the field in which they are engaged which is an error based on limited knowledge. A machinist for instance has an interest in literature relating to the operation of the craft, but to suppose that his interest in technical literature goes no further than this is to suppose that he has no ambition beyond the ordinary product of his skill.

Whether a man is working in a machine shop, boiler shop or foundry or is in charge of boilers and engines as engineer, he is not only reading in matters relating to his work, but is no less frequently more interested in allied mechanical subjects about which he must know something to materially advance himself. He is always interested, and properly, in reading outside his immediate needs. The machinist recognizes that as foreman he will feel the need of some knowledge of pattern making and moulding, and the pattern maker, if in charge, must know something of machine work, and a good deal of moulding. So the moulder is always better for some knowledge of practices in other departments, and the engineer is interested in them all.

All progressive mechanics expect to be called to a position where general knowledge of mechanics and engineering is important and the properly progressive mechanic reads up to supply himself with the information required.

Chemistry and the Cast Iron Wheel

The outcome of the adoption of a chemical specification for cast iron wheels is rather interesting. When it was proposed a few years ago there was a good deal of vigorous opposition to it, and that despite the fact that the best foundries had for years been actually working to such specifications. So that we were really ready for such an addition to the specifications without being aware of the fact.

After the report of the committee had been presented a good deal of supporting evidence was brought out in the discussion.

In this discussion it was stated that the Lackawanna Railroad averaged very close to one wreck per week, due to the breakage of cast iron wheels. Of these 99 per cent have been on foreign equipment, and the failing wheels have been found to vary widely from the chemical composition called for in the recommended specifications, and that their composition was inferior to that suggested.

In searching for the reason for these failures it was found that in nearly every case the wheels were very high in combined carbon, some rising to as much as 1.50 per cent, while on very many it ranged between .90 and .95 per cent. Hence, by taking this high carbon into account the conclusion was reached that cast iron was made more brittle by high combined carbon. On the other hand, when the combined carbon is above .90 per cent the shrinkage is increased, making it more difficult to anneal out the shrinkage strains in the soaking pit.

In order to thoroughly test the theories of these specifications, the thermal test has been repeated on a single wheel as often as 10 or 11 times before failure occurred, and this was in exact accordance with this specification, using a 1¾ or 2 in. band, according to the weight of the wheel. This, undoubtedly, shows a wonderful improvement when we take into consideration that in the old specification wheels were accepted if they cracked within two minutes, provided they did not crack through into the thread.

It was urged that as it has been found that the specifications for steel wheels call for .85 per cent carbon as a maximum, the combined carbon of cast iron wheels should be lower, and this is checked by the fact that wheels which stand the thermal tests the best are those whose combined carbon runs below .75 per cent.

It has been found that it is not a difficult thing to control the combined carbon in the foundry. It has been found that when the total carbon ranges from 3.65 to 3.75

per cent there will be less shrinkage and a lower combined carbon than when the total combined carbon is about 3.00 per cent, and it is more difficult to remove the shrinkage strains from the wheels of the lower total carbon. This condition is brought about very largely by the wheel manufacturers not using sufficient coke to have the iron of a good high temperature. The best results have been obtained where iron has been melted using 1 lb. of coke to melt 8 lbs. of iron, while the practice has usually been to melt 10 lbs. of iron with 1 lb. of coke, which resulted in low total carbon, high combined carbon, high sulphur, high shrinkage and iron containing more or less blow holes, cold shot and dirt.

Manufacturing in Repair Shops

A question that used to be a live issue but is now seldom heard was: does it pay for a railroad company to manufacture its own rolling stock and machinery? It used to be an easy matter in years gone by for those in charge of the machinery department of railroads to build locomotives, cars, machine tools and many other appliances, charging the bulk of the expense to running repairs thereby making a showing of cheap work. Many a man with no engineering knowledge worthy of mention was permitted to build his own type of locomotive or car to say nothing of machine tools on the claim that they were cheaper than those on the market.

That claim was tolerated for years, but after a time railroad managers and others in authority began to look carefully into the cost of manufacturing devices; then arose a practice of exchanging cost cards which were fatal to the claims of the man who boasted about his own cars and locomotives. The information became wide spread, that railroad companies could not compete with the regular builders of rolling stock and machine tools, and few of the railroad repair shops now venture to make the claim that they can do the work cheaper than the concerns that regularly follow the business and possess the proper equipment for doing the work.

Peace and How to Secure It

General W. W. Atterbury, Vice President in charge of operation, Pennsylvania System, prepared a most able address for the Veteran Employees Association's picnic at Indianapolis, Ind., on July 21st, 1923.

The position of the railway in dealing with its great army of employees was clearly set forth in language so plain as to leave no doubt as to the company's intention to give the men "A Square Deal" at all times, regardless of criticism from sources not friendly to their methods of procedure. Among other trite sayings used in driving home a point was the following:

"The way to make peace is to make peace. You cannot make peace by making *rules for a fight*."

The views of two different groups of employees on the government ownership bogy is clearly set forth in the following resolutions:

The Association of Shop Craft Employees of the Eastern Region, Pennsylvania Railroad System, in Convention assembled at the Chamber of Commerce Building, Philadelphia, Pa., on June 20, 1923, formulated the following resolution:

"In view of the recent agitation and demands of the labor press and of designing political aspirants to force government ownership of the railroads in order to further their own personal greed and aspirations.

"We, the representatives of the Association of Shop Craft Employees of the Eastern Region, Pennsylvania Railroad System, in convention assembled, assert that such government ownership of railroads is contrary to best interests of the stockholders, the management and the employees, and that such ownership would not give to the public the service they have the right to demand; and we as employees are unalterably opposed to such ownership as unfair and against our own best interests, as well as those of our fellow citizens to whom we are desirous of giving our best service, which has always been characteristic of the employees of the great Pennsylvania Railroad System."

The Clerical Employees' Association of the Pennsylvania Northwest Region in a recent statement explaining the importance of discounting the statements of Senator La Follette and his associates which ridicule the present methods of rail management said:

"Should we, as railroad employees, stand silently aside and permit people who do not have sources for securing correct information to be misinformed by so-called progressive politicians? We are bound to be progressively put in the class of government employees who must, on account of their situation, accept very unsatisfactory conditions of employment without even a whisper concerning conditions or compensation, to say nothing of an equal voice in managing our own affairs, such as our association now provides.

"As happened in Chicago recently, government ownership would automatically result in committeemen being dismissed for even suggesting the probability of an opinion concerning our welfare. This very thing happened in the postal department wherein a number of men were summarily dismissed for forming an association which had for its purposes improving of conditions under which they were working. This forms a clear idea of what we could expect.

"Additionally, do not be deceived into thinking perhaps wages would be increased; there would be no war-time bond buying generosity to offset deficits caused by lack of ability for managerial responsibility until our wage level and working conditions would compare most favorably with other classes of government help—notably postal clerks."

Six Months' Traffic Breaks All Records

The railroads of the United States during the first six months this year carried the greatest freight traffic for any corresponding period of their history, according to the Bureau of Railway Economics, based on reports filed by the carriers.

Measured in net ton miles, it amounted to 225,435,608,000 net ton miles. This was an increase of 7 per cent. over the corresponding period in 1920, which had marked the previous record.

Compared with the first half of last year, when, however, freight traffic was reduced by the miners' strike which began on April 1 and continued until late in the summer, the total net ton miles for the first six months this year was an increase of more than 32 per cent. In the Eastern district, which was especially affected by the miners' strike, there was an increase over the first six months last year of 37.6 per cent. in freight traffic, while the Southern district reported an increase of 29½ per cent. In the Western district the increase was 26 per cent.

For the month of June alone freight traffic amounted to 38,000,994,000 net ton miles, or an increase of nearly 31 per cent., over the same month last year when the miners' strike was in progress. The Eastern district showed an increase of more than 46 per cent. in freight traffic, the Southern district 14 per cent. and the Western district 17 per cent. Freight traffic in June this year has only been exceeded twice during that month in previous years, once in June, 1917, and again in June, 1920.

Future of Railroads Regarded as Bright

A review of the railroad situation just made by the National Bank of Commerce looks upon the future of the railroads with optimism and calls attention to the outstanding factors of their performance and financial condition, in part, as follows:

The outstanding factor is the comparative ease with which this extraordinary large volume of traffic has been handled. Traffic congestion has been at a minimum and in spite of an unusually large percentage of bad-order cars and locomotives, resulting from the strike, the railroads, shortage of freight cars which was a problem last autumn has been pared down until at present a fair surplus exists. The proposition of locomotives in need of repair is being continuously reduced.

May Earn 5.75 Per Cent

There is better than a fair possibility that the standard return, 5.75 per cent., allowed the roads by the act of 1920, will be earned this year for the first time since the act became law.

Economy of operation has not been at the expense of maintenance. In the first five months of 1923 a larger sum was expended for maintenance of way and structures and of equipment than in the corresponding period of any preceding year with the exception of 1920.

Improved Service in Spite of Restriction

As a result of the limited earnings of the railroads and their difficulty in obtaining funds, the expansion of the railroad systems of the country is practically at a standstill.

The mileage of railroads in this country is less than in 1915, whereas during the preceding decade it increased by nearly one-fifth. It is estimated that the population of the continental United States has increased 12 per cent. since 1915, and the volume of industry and business probably even more. The number of locomotives and freight cars has remained practically stationary, although on account of increased average tractive power of the locomotives and average capacity of freight cars their freight handling capacity has increased.

New Legislation Unnecessary

The railroads are still threatened by further hampering legislation, so that operating officials are unable to lay plans for the future with reasonable assurance that they may be carried out. The act of 1920 should be given a fair trial in operation under favorable conditions before discarding it for some other form of legislation which may prove to be equally temporary.

Rates should be revised only after careful consideration, and operating expenses must continue to be watched with extreme care.

There should be no further additions to the heavy burden of taxation, which has more than doubled in the past decade.

Railroads Paying Out More in Taxes Than in Dividends

The railroads are today paying out more in taxes than they are in dividends, according to figures just compiled by the Bureau of Railway Economics from the records of the Interstate Commerce Commission.

Ten years ago—that is in 1913—the total dividends paid to railroad stockholders were about two and a half times the total railroad taxes. Last year—1922—the taxes paid were 11 per cent greater than the aggregate dividends.

The cash dividends paid in 1913 totaled $322,300,406, and the taxes $127,725,809. Dividends in 1922 totaled $271,576,000 and taxes $301,003,227. In the ten-year period, 1913 to 1922, therefore, taxes increased about 135 per cent, while dividends decreased about 16 per cent.

The increase in taxes is due in part to an increase of approximately five billion dollars in the property investment of the railroads between 1913 and 1922. But, while the total investment and value of rail property devoted to public service during this period has increased about 33 per cent, and taxes upon the property 135 per cent, the total compensation to railway stockholders has decreased 16 per cent.

The record of the total sums of money paid out by the railroads in cash dividends and taxes from 1913 to 1922, inclusive, is given in the accompanying table. The figures for 1913 to 1915, inclusive, are for the year ending June 30, and for Class I and II roads, the latter of which constitute from 2 to 3 per cent of the total. The figures for 1916 and subsequent years are for Class I roads only, and for the calendar year.

Aggregate Dividends and Taxes Paid

Year	Total Dividends Paid	Total Taxes Paid
1913	$322,300,406	$127,725,809
1914	376,089,785	141,942,711
1915	259,809,520	139,313,602
1916	306,176,937	162,474,735
1917	322,395,779	215,146,471
1918	275,336,547	223,595,268
1919	278,516,908	232,363,445
1920	271,731,669	282,750,533
1921	298,511,328	275,128,134
1922	271,576,000	301,003,227

Dividends and Taxes Per Mile of Line

Taxes now exceed dividends not only as to aggregates, but also per mile of line. Comparison of dividends and taxes paid per mile of line in 1913 and 1922 show that ten years ago dividends per mile were almost three times the taxes, while last year the taxes exceeded the dividends. In 1913 $1,446 was paid out in dividends per mile of line compared with $531 in taxes. In 1922 $1,156 was paid out in dividends per mile of line and $1,282 in taxes.

Railroads to Have 100th Anniversary

The American Railway Association has announced that plans are under way for a railroad centennial celebration. Committees have been appointed to collect interesting data and arrange for a miniature World's Fair. Three railway organizations have adopted resolutions urging the appropriate observation of 100 years of American railroad development, the American Railway Engineering Association, American Railway Development Association and the Mechanical Division of the American Railway Association.

No place or date has yet been settled upon. Suggestions have been made to hold a central celebration in Chicago with a number of smaller celebrations in other cities.

The American railroads will participate in 1925 in the English celebration of the opening of the first railway in the world, under the auspices of the International Railway Congress, but it is the desire of the American Railway Association to commemorate the American centennial, which comes in 1928.

According to the plans of the committee the American Railway Centennial will show how railway transportation has made possible the development of the United States within the last 100 years.

Snap Shots—By the Wanderer

It is a delicate matter that of discharging a man for an offense. The railroad may be losing more than it can possibly gain. Of course, if a man is incorrigible, and commits one offense after another, apparently not learning by his experience, there is but one course open to the officer in charge. But for the reliable man, the man who has an unsullied record of years of reliable service, it is poor policy to discharge him for a single lapse of attention, however serious that lapse may have been in property damage or personal injuries.

The naturally prudent man will learn such a lesson from a disaster that the chances of his again failing are almost infinitely remote. He knows the road, and if he feels that he has been shown due consideration in case of a lapse, and that his past record is appreciated, that consideration and appreciation will bind his loyalty to the company with hoops of steel.

I have a case in mind of a road that proceeds on this principle, and it seems to be a paying proposition. In one instance there was such a bad lapse that the man was indicted for manslaughter, but acquitted. He was quietly put back into service, and has a five years' record without a demerit. Prior to the accident he had had an unblemished record of twenty years.

The question simply arises, why ruin a good man and lose his services because of a single failure? But, of course, no hard and fast rule can be laid down.

It is generally conceded that the most successful manager is the man who gets closest to his men and inspires that feeling of loyalty which is about the greatest asset that a man can have and the reasons for which are most illusive and intangible. In a specific case we can say that it is the result of bon camaraderie, good fellowship and what not, and yet in another case the man arousing it may have none of these qualities.

But in the last analysis it is usually the result of some direct personal contact. It is often a case of "like master, like man." Where the head is close to his immediate subordinates and arouses in them that valuable loyalty, it is more than likely that they will have the same characteristics and bind the rank and file to themselves in the same way.

How far can this be carried? Given the most engaging characteristics for the head, at what point in the development of an organization does it become so big that the personal charm of the chief will fail to carry over?

Of course, the smaller the road the more close can be the relationship between the head and the feet of an organization. I have seen some pretty fair-sized properties in which the superintendent of motive power was on close terms with shop and even gang foremen, and I have seen some pretty small roads where the superintendent of motive power knew mighty little of the men immediately below him. The malady commonly known as a "swelled head" is responsible for more discontent and disloyalty than almost any other item in the mental make-up of an officer, with the exception of overbearing insolence.

Loyalty and comradeship are very apt to go hand in hand, and I am wondering whether either can be efficiently maintained if there is to be the great enforced consolidations of big and little properties that seems to be in the air.

Loyalty usually spells economy, and while these big consolidations may make for economy in the overhead of general offices and departmental heads, it is quite probable that they may be the cause of so many little leaks that the spectacular saving in overhead will be more than offset by the innumerable dribblets, caused by the "don't cares" of thousands of men.

The little son of a friend of mine had reached the age of five. He was a good little chap, affectionate and obedient, but a boy through and through to his finger tips. Active and self-reliant, his mother thought it about time that he was sent to school, and so put him in a kindergarten.

The little fellow went there and did as he was told most obediently. He learned their little songs and cut out the papers as he was told. In fact, he was a model little pupil.

At the end of two weeks he went to his mother and said: "Mamma, if you want me to go to school I'll go and I'll study hard, but I think that I can manage my own play."

This is apropos of a suggestion to the effect that the officers of the American Railway Association exercise a sort of paternal oversight over the selection of subjects and the choice of speakers by the railroad clubs.

It is hardly conceivable that a more unpopular move could be made, or one which, if carried into effect, would be more disastrous to the vigorous life of the clubs.

There are some who have their doubts as to the beneficence of the paternalism that has been extended to cover the various associations of railroad employes; and if it came to spreading it over those associations containing large numbers of supply men, there would probably be a revolt on the grounds that the clubs are quite capable of managing their own play.

Lord Dundreary once sagely remarked that "there are some things no fellow can find out." And the action of men who are called upon to vote on a strike proposal "passeth all understanding." It appears to be a rule in women's clubs, of which married men are apt to hear a good deal, that it is very bad form to vote in the negative on any subject that may be proposed. It would hurt the feelings of the proposer and she might resort to tears, which would be distressing and awkward. So it is much easier and contributes greatly to the smoothness of the proceedings to vote "aye," and then discuss the matter over the teacups where there is ample opportunity to play the cat and tear the proposition and the proposer to shreds.

This bad form business seems to be the only explanation possible for the shop vote on piece work when the government took control of the railways. Of course, piece work has been anathema to labor leaders for years because of the selective process which it exerts on ability. It gives the good man a chance to show that he is better than the other fellow, which is distressing and tends to disrupt the idea that all men are created equal. As to their being created free, that is quite another question.

So the plausible explanation is that when the question of the abolition of piece work was put, the women's club formula of "Aye" in good form carried the day.

This seems passing strange in view of the fact that piece work enabled a man to earn more than he could by the fixed hourly wage.

Now comes the report of the Interstate Commerce Commission to the effect that blacksmiths, boiler makers, car repairmen and others are earning from 30 to 50 per cent more at piece work than their fellows on an hourly wage. Yet it would probably be a safe wager that these same men, en bloc, would again vote to abolish piece work at the suggestion of a leader, while individually every mother's son of them would like to keep it up for himself. Truly, Dundreary was right, and so, too, was

Puck when he made his estimate of humanity in his "What fools these mortals be."

In the case of Richard Meynell, Mrs. Humphrey Ward draws a fine picture of what has come to be known as English fair play. A prominent clergyman is to be tried before an ecclesiastical court for heresy. In the midst of the preliminaries an overzealous churchman injects some false and scandalous charges against the defendant. There is a sensation, gossip galore and much smacking of the lips of the evil minded. But his bishop holds off, refuses to believe the false reports and even while they are in full swing the overzealous one falls into disrepute, and when they are disproven he is cast out and ostracized by the party which he desired to help by this disgraceful means.

It is a pity that a little more of this fair play spirit cannot be injected into our own controversies. Most people like to believe evil rather than good, and when Mr. Richberg gives the railway valuation of the Interstate Commerce Commission as the cause for our present freight rates, and an attack is made on the honesty and accuracy of the valuation, he is using methods that are far and away removed from fair play. The difficulty is that most people believe, without question, that which they would like to have a fact. So when a man states that the valuation is too high or that railroad management is corrupt, the unthinking mass applaud and roll the scandalous portion over their tongues in an ecstacy of delight.

The railroads have been urged, and quite properly, to take the public into their confidence. But can they always do it with an assurance that that confidence will not be betrayed.

Personally I often receive information from railroad officials that would be interesting and valuable for the public to know, but I am asked to keep it confidential, because no matter how thoroughly or carefully it might be presented, it would be impossible to so do it, that some yellow journal or loud-mouthed demagogue could not so distort the facts while adhering to the color of the truth, that in *its* presentation to the public it would appear in quite a different light, and that dear, benighted, stupid, unthinking public would be led to believe that it was being robbed and imposed upon in a way that the drawing and quartering of the offenders would be a mild and humane penalty to inflict.

It is because of such conditions as these that decent men are in despair. And again the question arises as to how far the men actually believe the statements made by their leaders, and how much their acquiescence is due to fear of a very militant minority.

I suppose the dining car is a product of, shall I say, over-civilization. The result of the same sort of a demand that comes from the man, who at home mows his lawn, washes dishes and beats the rugs, but who, when traveling at some one else's expense, requires a porter to carry his valise and hand him his hat. At home he quite relishes a ham sandwich and a glass of milk for lunch, or warmed up potatoes and cold beef for dinner. But on the cars he wants immaculate linen, an obsequious waiter and a porterhouse steak.

But the linen and porter and steak cannot be provided on a dining car at a profit, in spite of high prices. And prices are crowded up to the last notch that the traffic will bear and then some.

After all, aren't conditions about what they are at many big hotels? What proportion of their guests do these hotels feed? In a certain city there are two very large and expensive hotels in the same block, with a Childs' restaurant between them, and very many of their guests breakfast and lunch at Childs. In another city the proprietor of a moderate priced restaurant is making a fortune feeding the guests of a big hotel across the street.

I don't know the percentage of big hotel guests who patronize its dining rooms, but it is small, and the proportion of passengers on trains that eat in the dining cars is probably smaller still. So why is it necessary to cater at such an expense to the extravagant few? Why can't people be content to picnic occasionally? No one feels that he is getting his money's worth on a dining car, and yet every patron is an object of charity. It does seem as though there should be some solution to the dining car problem. Simpler tastes on the part of the traveling public, or at least tastes more in accord with home conditions and surroundings; lower prices to meet popular purses, might accomplish it, but would it work? I am not enough of a psychologist to say. Again it may be remarked that it is much simpler to suggest belling the cat than it is to perform the operation of doing it.

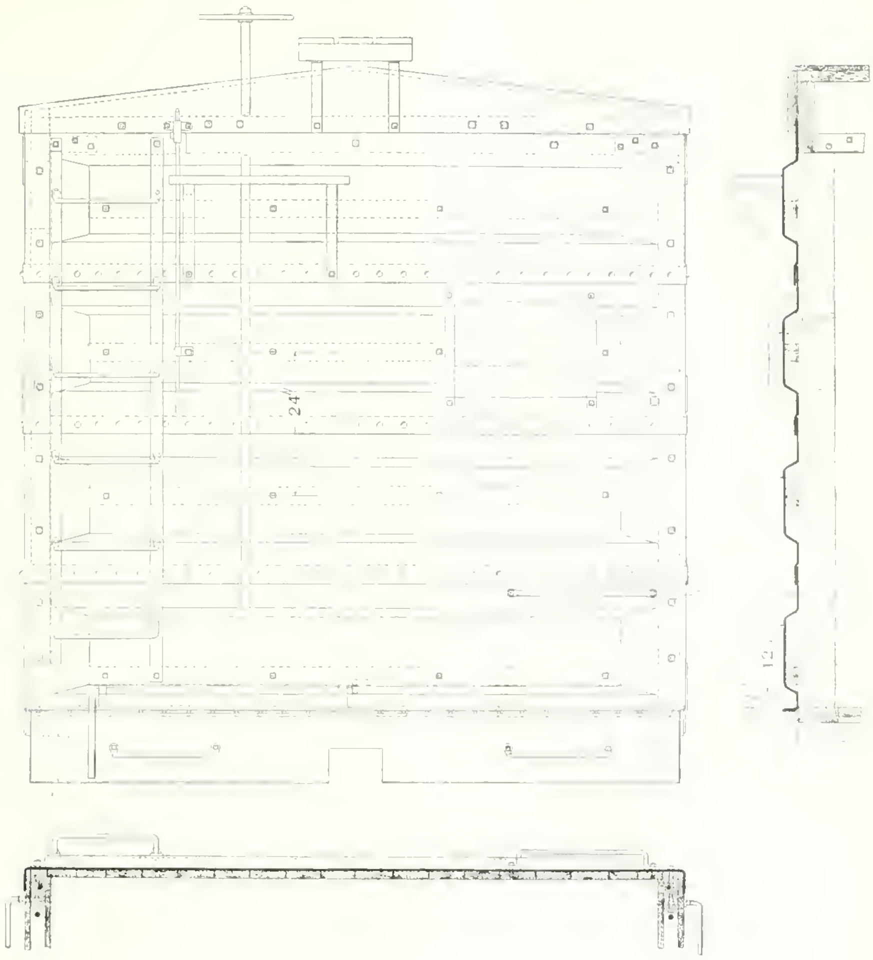
Hutchins Channel Steel End for Box and Gondola Cars

The end construction of freight cars has come to be a specialty of itself. The demand came because of the great increase in car capacities, and the tendency of the heavy lading to shift, because of rough handling, and to put a corresponding pressure upon the end framing of the car. It is difficult to state as to just what portion of this thrust has to be carried by the end of the car in any given case, but from a theoretical standpoint, if a car is stopped from a speed of 4½ miles an hour in 2½ ft. the lading exerts a total thrust of about one half its weight, which

Car Equipped With Hutchins Channel Steel End must be taken up by the car framing.

The design for meeting this thrust upon the end of the car that is here illustrated is one that is manufactured by the Hutchins Car Roofing Co. of Detroit, Mich. The end is shown in both the halftone and line engravings, as applied to a box car, though it is also used for gondola cars. It is of steel pressed to a channel section, with the channels or troughs tapering out to the flat at the ends. For box cars the channels are 12½ in. wide and 2½ in. deep. For gondola cars they are either 8 in. or 9 in. wide and from 2½ in. to 3½ in. deep, as may be required, and they are formed so as to extend outwardly or inwardly, as far as the inside of the car is concerned. In the illustrations they are shown as projecting outwardly, on the line engraving and inwardly on the reproduction of the photograph. Four or five sections will cover the end of a box car, depending upon its height, and two or three will do the same for gondola car. The sections overlap like the clapboards of a house so that leakage of water into the interior even in the most driving of storms is effectually prevented, and they are held together by ½ in. rivets spaced 4 in. between centers.

One of the features of this channel end is that the metal is not abused in the forming, for the reason that only one channel is pressed in each section, and the thickness of the steel in every section is the same after as before forming. Where the sections lap and are riveted, a certain amount of strength is gained in the completed end, and calculations show that as a whole it is exceedingly strong.



Elevation, Section and Plan of Hutchins Channel Steel Car End

A reference to the line engraving will show it to be an exceedingly easy matter to take out one section and replace it, thus avoiding the necessity of replacing the whole or even a half the end. This is an especially valuable feature in coal cars where the bottom is subjected to excessive rusting.

In general appearance the end closely resembles the trough flooring used in bridge construction. It has flat bearing surfaces for the feet of any outside attachments. It is made of material ¼ in. thick for the lower sections and 3/16 in. thick for the upper, and when the sections are in place the inside faces are flush with the outside faces of the corner posts. The simplicity of the construction of this end ought to appeal to the car repairer. Not only are the individual sections easily removed and replaced, but the channel form is so open and accessible that it lends itself readily to straightening with the tools ordinarily available at the repair tracks.

New Equipment Orders for Erie R. R.

Orders for new equipment reaching an approximate total of $6,500,000 has been announced by Franklin G. Robbins, vice-president in charge of Chicago Region of the Erie Railroad. Mr. Robbins has also reported the closing of contracts for the rebuilding of 4,450 box cars, 1,000 gondola cars and 100 refrigerator cars.

The new rolling stock on Erie requisition placed with various car building concerns, includes: 1,000 70-ton gondolas to be built by the Youngstown Steel Car Company; 1,000 70-ton gondolas, to be built by the Standard Steel Car Company; 1,000 40-ton box cars to be built by the Pressed Steel Car Company; 1,000 40-ton automobile cars to be built by the Standard Steel Car Company.

The car rebuilding contracts have been placed as follows: 1,000 gondola cars, Standard Steel Car Company; 100 refrigerator cars, Standard Steel Car Company; 450 box cars, Illinois Car Company; 1,000 box cars Buffalo Steel Car Company; 1,000 box cars, Youngstown Steel Car Company; 1,000 box cars Standard Tank Car Company; 1,000 box cars Standard Steel Car Company.

Westinghouse Motor Renders Long Service

Still in use daily after 27 consecutive years of service in the Sacramento, Cal., shop of the Southern Pacific Railroad, is the remarkable achievement of a motor, the product of the Westinghouse Electric and Manufacturing Company.

The motor, which is a Westinghouse Tesla Type B alternating current induction motor, 15 horsepower, 1,200 revolutions per minute, three-phase, 60 cycles, 500 volts, was installed in 1896, only two years after this type of motor was developed. It has a rotating primary and a stationary secondary provided with a series of U-shaped resistance grids bolted to the rear ends of the secondary bars for starting duty.

When the motor is up to speed, the secondary is short circuited by moving the large level at the top of the motor frame, which is connected to the large copper ring visible inside at the top of the frame. This ring mounts a number of ringers which will make contact with the square bosses at the upper ends of the cross connections.

New Type of Trolley for Heavy Electric Traction

Tests Show Currents Exceeding 5,000 Amperes Collected by a Single Pantagraph without Sparking

Tests which disclosed a new type of overhead trolley construction for electric locomotives with a greater capacity for current collection than any type now in use, were held July 16, 17 and 18 at the Erie., Pa., works of the General Electric Company before a distinguished group of railway executives, engineers and operating men.

These public trials were for the purpose of showing that the heaviest future railway traffic, up to four times present capacity, can be successfully handled by electric locomotives operating on the direct-current system, and a new record for current collection of over 5,000 amperes was set up. This is more than twice the amount of current now collected for normal requirements. Current collection varying between 4,000 and 5,200 amperes at speeds from 50 to 60 miles per hour were made. The test train consisted of a 110-ton passenger type locomotive arranged for operation on 750/1,500 volts and equipped with four bipolar gearless motors. A gondola and New York Central observation coach was attached. On account of the short length of the cab, the second pantagraph was mounted on this gondola to simulate operating conditions. The normal pressure of the pantagraph against the trolly wire was between 30 and 35 lbs.

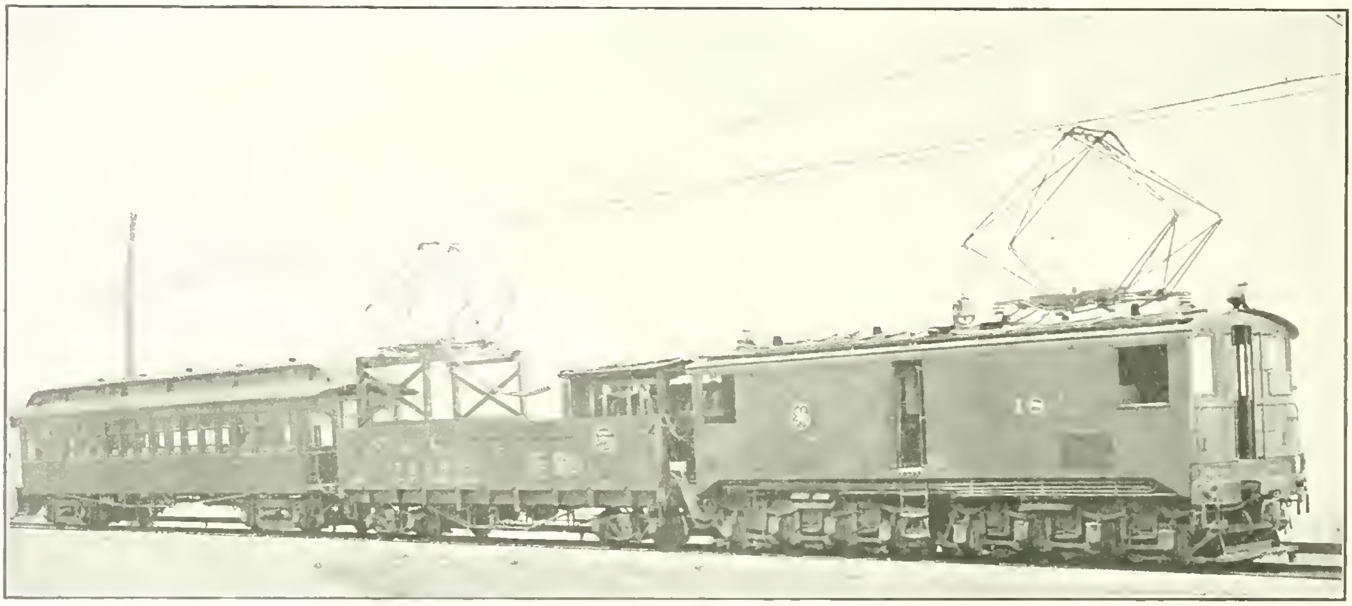
By means of remote controlled contactors, sections of loading grids indicated in the gondola were inserted or removed so as to draw whatever current was called for under each particular test.

Some of the guests were invited to ride in the locomotive cab. Others rode in the observation coach, which was equipped with indicating instruments to show the amount of current collected and the speed of the train.

Four tests were made. Number one collecting 4,000 amperes and 1,500 volts at 60 m. p. h. with one pantagraph; number two, 4,000 amperes at 50 to 60 m. p. h., 850 volts; number three, 5,000 amperes at 850 volts, 30 m. p. h., two pantagraphs; number four, 5,000 amperes at 850 volts, 50 to 60 m. p. h. As a final exhibition a test was made collecting 5,400 amperes, 850 volts, at 58 m. p. h., with one pantagraph setting the high record of the trials. The higher amperage tests were made at the reduced voltage because of the limited power available. Witnesses of the tests stationed on the observation towers remarked on the complete absence of sparking.

To provide facilities the General Electric Company makes use of the Eastern Division of the East Erie Commercial Railroad. These tracks are equipped with up-to-date overhead line construction and third rail and are supplied from a substation with whatever trolley voltage may be required.

That portion of the track which is used for testing purposes is at present 2¾ miles in length. An extension is now under construction which will give a total length of 4¼ miles. The length of track used for high speed running is about 2½ miles long, the remainder being used for slowing down the train. Included in this high-speed section there is 1 mile of level tangent track. Beyond this tangent there is a slightly ascending grade with curves of from 1 to 1½ degrees. The rail weighs 100 lbs. per yard and is laid with 24" tie spacing in slag or stone ballast. There is also about 1 mile of extra rail which is used for testing odd-gauge locomotives.



Train With Gondola and Observation Car Used in General Electric Company's Current Collection Tests

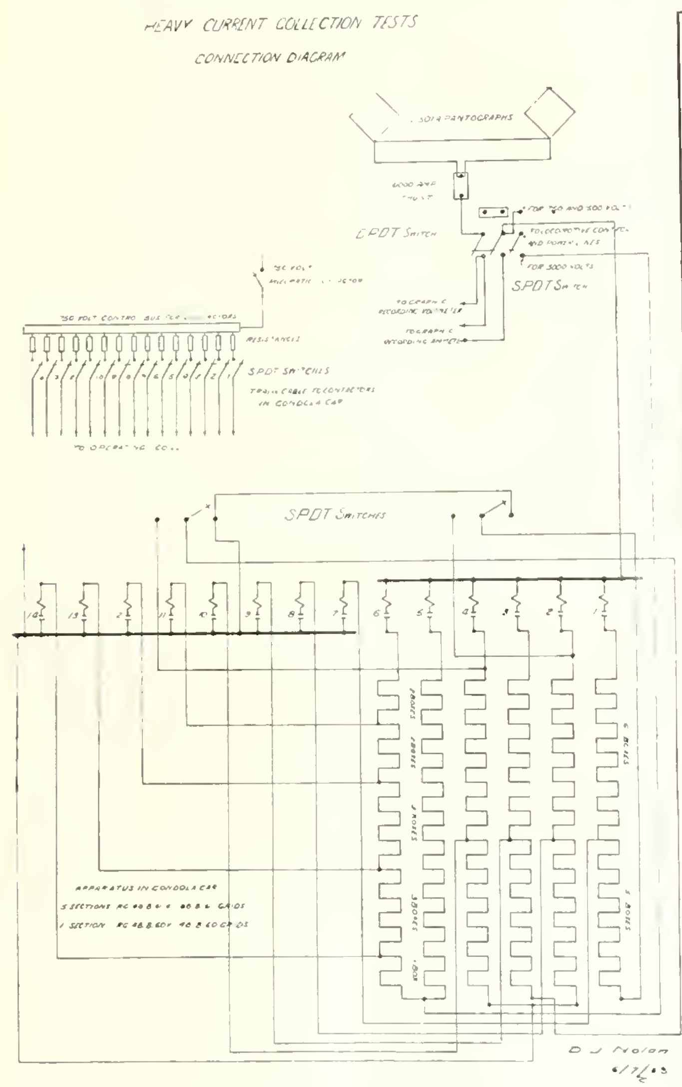
The working conductor was located 22 feet above the rail. The overhead construction was compound catenary with a steel messenger and a secondary copper messenger to which had been "laced" duplex copper working conductors. A portion of the secondary messenger was 1,000,000 c. m. copper and the remainder 750,000 c. m. The overhead line was fed at one point from the substation in building No. 60 of the G. E. plant.

The steel supporting structures begin about 600 feet west of the substation with latticed column bridges extending up to bridge No. 13. Bridges Nos. 14 to 18, inclusive, are Bethlehem column bridges. The structures from No. 19 to No. 23 are latticed channel bracket poles; from No. 24 to No. 28, inclusive, 10" Bethlehem bracket poles; from No. 29 to No. 33, inclusive, 9" Bethlehem bracket poles. Bridge No. 34 is latticed column type used for an anchor. The steel structures are spaced 300 feet throughout. All of the steel structural work was supplied by the Archibald Brady Company, Syracuse, N. Y.

The primary messenger consisted of a 5/8" 7-strand high-strength steel cable from structure No. 1 to No. 34, at points 30 feet apart. The working conductors were supported from the secondary messenger by clips spaced 15 feet apart on each wire.

To conveniently witness the current collection observation towers had been erected at a height of approximately the top of the pantagraph, at various points along the track.

The substation in building No. 60 contains two synchronous motor generator sets with switching equipment suitable for connecting these units to supply any trolley potential from 600 to 3,000 volts. One of these sets has a rated capacity of 1,000 kw. and consists of two 500 kw. 1,500/3,000 volt generators direct connected to a synchronous motor. The second unit is of similar construction but with two 750 kw. generators. Full capacity can be obtained with both series and parallel connection, and lower voltages can be obtained by adjusting the rheostats in the generator fields. Both of these sets are designed to operate at three times load for short periods, and a total of 6,000 kw. can be obtained, the limit of the power supply.



Connection Diagram Showing Wiring of Locomotive and Car Used in Connection With Tests

View of Overhead and Feeder

The secondary messenger was a 1,000,000 circular mill stranded copper cable between bridges No. 1 and No. 15, and a 750,000 circular mill stranded copper cable from bridges No. 15 to No. 34.

From bridges No. 1 to No. 16 and from No. 20 to No. 34 the working conductor consists of two No. 0000 grooved hard drawn copper wires hanging side by side. From bridges No. 16 to No. 20 two No. 000000 copper wires are used.

The laced suspension was installed throughout with a No. 0 stranded copper cable supporting the working conductors from the secondary messenger. Droppers from the primary messenger supported the secondary messenger

Steam Road Electrification

By R. L. Hermann, Mgr. Transportation Div., Westinghouse Electric & Mfg. Co., Detroit, Mich.

Railroads are the forerunners of national expansion because transportation is the foundation of our industrial, agricultural, economic and social enterprises of today. With our network of steam roads as they exist today and our transportation systems virtually at a standstill, in so far as new development is concerned, we have before us a very grave question to be considered for the near future if we are to cope with the rapid industrial expansion and exigency for true economics.

A century ago we were in the "man and horse" era and transportation was simple. For the past twenty years we have been living in a much different era. Taking this period as a criterion we must of necessity look to the future era with the expectation of great changes and methods of operation.

Today we have approximately 253,000 miles of standard gauge trackage over which are operated approximately 70,000 steam locomotives and 2,500,000 cars of all classes. The present system exchanges fruits and minerals of

California for shoes and textiles of New England and furniture from Grand Rapids, thus placing our industries on a more economic basis.

In 1897 the average cost per ton mile of freight movements in the United States was .798 cents, while in 1916, the last year of private ownership, it was .716 cents, a reduction of over ten per cent.

This was accomplished by the use of the larger and more efficient locomotives, equipped with superheaters and stokers, larger capacity cars, faster operating speeds, heavier trains, grade and curve revisions, double tracking, grade separations in entry into cities, electric signals, et cetera, all of which has contributed to greater traffic densities.

Many of the main trunk lines, however, have practically reached their possibilities of expansion in trackage because of the enormous cost involved in the physical addition. The ever increasing traffic demands must be met. Consequently, we must seek a means of increasing car handling capacity of present tracks.

This can be accomplished by handling larger units and at higher speeds. The electric locomotive supplies these very factors. It does not seem unreasonable to expect that train sizes will be limited only by the strength of the draft gear and car underframing, and speeds only by alignment and car journal performances. Therefore, we may feel confident that this detail will be mastered.

In the electric locomotive we have available a motive power unit able to produce, under control of one operator, as great a tractive effort as the strength of the cars will permit at present. Experience with the electric locomotive has proved that they are extraordinarily reliable, relatively cheap to maintain and available for service a large percentage of the time. When properly designed for the service to be performed, and when operated within rated capacity, the routine inspection and running adjustments can be made in a very short time.

The fact that the electric locomotive does not need to stop for water and coal, especially where more than one locomotive is used per train, is in itself a great time saver. No fires to be cleaned and drawn and no boilers to be washed makes for time saving and economies of operation.

Regenerative braking has proved itself a wonderful advantage in heavy grade operation. The saving in power, due to the pump back, and the saving of wheel and brake shoe wear all show marked economies. The air brakes are held in reserve for use in emergency and for coming to a complete stop. While all these facts show savings, we must not overlook the principal item, namely, the increased reliability and safety of operation which regeneration brings with it.

It is estimated that at present the railroads of the United States consume 150,000,000 tons of coal in generating power to handle the nation's transportation business. It is possible to save over half of the coal used by the electrification of our important and most heavily burdened systems. In fact, actual test runs on one electrified road showed 66 per cent saving. These figures are based on steam plant operation. Of course the economies would be much greater were hydro-electric plants used.

In addition to the saving of fuel, the coal cars used to haul coal for driving steam locomotives may be released for other revenue freight. These comprise approximately 20 per cent of the present gross revenue-ton mileage of the railroads.

A comparison of the cost of equivalent steam and electric motive power shows the first cost to be approximately the same. Although electric locomotives cost about 50 per cent more than steam for equal driver weight, the smaller number of electric locomotives required to handle an equal tonnage, due to their availability for service, offsets this handicap.

In maintenance cost the electric locomotive shows great advantages over the steam. The figures available, including all engine service charges, indicate that electric locomotives of the largest type can be maintained for 50 per cent of that of the steam locomotive in similar service.

Electrification invariably cuts out many steam road division points as the electric locomotive can be taken through. In one case engine terminals were maintained at four intervals of 110 miles each. Today the electric locomotives operate the whole distance of 440 miles. These locomotives have made 12,000 miles each per 30-day month and 766 miles in a 24-hour period. Only the electric locomotive could make such a performance possible, as the smooth operation, due to the absence of reciprocating parts, allows an electric engine to be safely used in long hauls.

An electric locomotive will handle heavy tonnage on mountain grades at twice the speed of a steam locomotive and will operate more efficiently, especially in cold weather. The reduction in number of trains resulting from the greater capacity and the greater speed of the electric locomotive not only relieves congestion, but at the same time will increase the tonnage capacity of a single track mountain grade division or any heavy duty division from 50 to 100 per cent over steam performance.

The only possible objection to electrification is the large investment required. This objection can be sustained only if it can be shown that electrification fails to effect economies sufficient to pay a satisfactory return, or that the same capacity for moving traffic could be obtained at lower cost by other means. Each case must be considered on its merits and all of the factors considered. Obviously only those roads or parts will be electrified where it can be shown that one of two conditions exist:

(1) Either a given limitation can be only overcome by electrification, as in the case of long tunnels, heavy grades, or

(2) A given traffic capacity can be obtained by electrification with sufficient operating economy over steam to justify the extra investment.

The use of electric power offers to transportation industry a new tool—one that permits, because of its characteristics, new operating methods and the ultimate accomplishment of results apparently impossible with previous means.

These fields may be outlined as follows:

(1) Congested terminals in large cities, often involving tunnel approaches.

(2) Heavy suburban service.

(3) Heavy grade divisions carrying dense traffic and under existing operating methods limiting the carrying capacity of a whole system.

(4) Tunnels on main and trunk lines.

(5) Sections remote from suitable fuel supplies and where abundant hydro-electric power is available.

The transportation system of this country is of vital interest. All electrification projects should anticipate the future for ease of expansion or changes. Any system which meets only the immediate traffic requirements or presents serious limitations to future growth must be looked upon with doubt.

The ultimate system should be comprehensive, adequate to manipulate the railways problems in its varied requirements and present the greatest possibilities for future development. It should be flexible in all its phases. It should be able to handle all service from the lightest to the heaviest with a minimum road investment, including main line service, terminals, yards, suburban service, and multiple unit service. It should *not* be simply an aggregate of individual solutions of the various problems.

Just reflect for a moment on what alternating current has meant to our electrical and industrial activities and development, and then picture in your mind the fact that less than 1 per cent of the total steam mileage is electrified today. Is it reasonable then to think that we can arbitrarily adopt some one given system now for all future time? Certainly it would seem logical to adopt the electric locomotive to the power system and not the system to fit the locomotive. What is the logical power system to convey the millions of horsepower of energy that will be required for the electrified steam railroads of the future if our present standard for transmission of power is any criterion? The needs of the railroads as to future capacity and operations are paramount. Therefore, the electrical industry and the generation and distribution of power, as well, should subserve their needs.

Statistics show that our freight traffic doubles every twelve years. The present transportation systems have had great difficulty handling 450 billion ton-miles in recent years. What will happen under the load of 900 billion ton-miles in 1935 or sooner? Electrification is, therefore, destined to be a big factor in the solution of the problem.

The Development of the Car Axle on the Pennsylvania

By GEO. L. FOWLER

Among the many details that enter into the construction of the modern car an item that was given the closest attention during the administration of Theo. N. Ely as superintendent of motive power was that of the designing of car axles. The Master Car Builders' Association had adopted a standard axle in 1873. It was adopted without being limited in any way, to the weight that it was to carry, and from the discussion before the association there was little or no information as to its actual strength and no calculations of that strength were presented. It was not until 1889 that the capacity of the car to be carried by an axle was specified, and that was in connection with the one adopted for cars of sixty thousand pounds capacity.

Meanwhile the Pennsylvania R.R. had adopted and put into service large numbers of the standard axles, and had had considerable trouble because of breakage, especially under the passenger equipment. The natural impulse was to make the axle heavier, along the old lines used to make the weak parts stronger.

But this was not the scientific method of procedure.

In the early days the axle had been made cylindrical between the wheel seats. It was the easy and natural form to assume by men who were working by the rule-of-thumb, and it held its place from the start up to the seventies. Soon after John W. Cloud was appointed engineer of tests he made a calculation of the distribution of the stresses to which a car axle is subjected and proceeded to design an axle that should be so proportioned as to properly carry the stresses. And this was the first step in advance that had been made in car axle design and was the first instance in which the stresses to which it had been subjected had been analyzed.

Again in the early days iron was used as an axle material, and all specifications called for hammered scrap. As already stated, the Pennsylvania Railroad had had a good deal of trouble with axle breakages which did not end with the adoption of the tapered form, and Mr. Ely started an investigation as to the reason why. In order to avoid all possibility of bad material and faulty workmanship getting in to produce weaknesses, it had been the custom of the road to hammer up its own selected scrap and make its own axles. Still breakages were distressingly frequent. Experiments were then made of forging axles from new double-rolled muck bars. The axles that were made in this way were so markedly superior to the old scrap axles that breakages practically disappeared for a time at least, and the road definitely wrote into its specifications that all axles should be made from double rolled muck bars. It was quite characteristic of the policy of the road to do such a thing; for, although the use of the new material added two cents or more to the cost of the axle per pound, and this amounted to a large sum when annual consumption was considered, the extra cost was not allowed to weigh in the balance as compared with the increase of safety that was thereby attained; and, in doing this, the Pennsylvania stood almost alone, because other roads continued to use the hammered scrap axle for a long time.

This change of material, then, marked the second step in the development of the axle of today.

But the improvements in steel making and the lessening cost of that product added to its greater strength and more desirable physical qualities, soon brought it into the field as an active and victorious competitor with the forged muck bar axles, so that the latter was compelled to give way, the third step in axle development was taken and mild steel became the material of which axles were made.

But paralleling and, indeed, outstripping these improvements in the form and material of axles, was steady and rapid growth in the weights of cars and the speeds of trains. So that though the strength had been greatly increased, the fiber stresses per square inch of section had experienced a still greater increase and breakages were then the cause of serious trouble and danger. From an analysis of the stresses it was evident that the material was too weak to sustain them and either a better material must be used or a larger axle substituted for the one that was standard at the time.

Almost the same course of events had followed in the development of crankpin material for locomotives, but here, when the time came for an improvement of the steel used, or an increase of size it was the improvement that had to be effected, because there was no room in the hub or crank of the driving wheel to accommodate a larger pin. Hence, with the path thus blazed, the car axle was brought up to the requirements by the same route.

The Pennsylvania Railroad was the first to use steel axles in the United States, and from about 1871 to 1875 had used the Krupp product under its cars. But at that latter date the Midvale Steel Works, which had been established in 1864, entered the field as a manufacturer of steel axles. The first axles were made of mild steel carrying about 0.26 per cent of carbon. With this composition the metal had a tensile strength of about 68,000 lbs. while its limit of elasticity was about 33,000 lbs.

These axles were very satisfactory at first, but later, when loads were increased, breakages occurred to an alarming extent. As it is with the limit of elasticity that determines the life of an axle and its real factor of safety, it was decided that, the objections to increasing the size of the axle being so very great, it would be better to so change the character of the steel that the limit of elasticity would be raised and thus, by using a more rigid axle avoid the breakages that were occurring with the axles then used. This was done, and the means used was to raise the carbon content of the steel to 0.45 per cent. This raised the limit of elasticity to 43,000 lbs. adding materially to the real factor of safety and effectually stopping the breakage of axles which had been such a source of trouble and danger.

Automatic Train Control on the Pennsylvania Railroad

Results of tests of an automatic train control system of the road's own design under practical operating conditions, have been conducted for several weeks on the Lewistown Branch of the Pennsylvania Railroad between Lewistown Junction and Sunbury, Pa. Announcement is authorized by the Company's Train Control Committee, which is headed by A. H. Rudd, Chief Signal Engineer, that the results thus far obtained have been extremely encouraging and justify hopes that the system may provide a successful solution of the problem of preventing train collisions automatically, regardless of human failures.

Nearly a year was occupied in designing and trying out the necessary apparatus before the actual tests could begin. The system has been in operation throughout the entire Lewistown Branch since July 11, and the movements of all trains both freight and passenger, have been subject to its control. The entire trackage of the branch, which is approximately fifty miles in length together with twelve locomotives, the entire number operated on the branch have been equipped with the necessary electrical and other devices.

The purpose of the automatic train control system is to make impossible accidents caused by train collision, whether resulting from the imperfect reading of signals, from disregard of signals or other forms of human failure, or from failure of the signals themselves. This object is accomplished by a combination of electrical, pneumatic, and mechanical devices applied both to the track and to the locomotive. These devices automatically slow down, or when required bring to a complete stop, any train which approaches too closely to another on the same track, whether going in the same or opposite directions, or when switches are improperly left open. Protective track sections of any length, suited to local operating conditions, may be established. In the case of the Lewistown Branch the sections average about one mile in length.

The first step in establishing the system was to equip the track so as to enable it to carry an alternating current. The appliances and devices for these purposes are practically the same as those used in the existing visual block signal systems.

Every engine is equipped with electrical apparatus which, without actually touching the rail, picks up the current from the track by induction. This current, after being "stepped up" to a sufficient power, performs two functions. One is to operate the cab signals, which are three in number. The other is to operate the air brakes if another train is approached too closely or proper rates of speed are exceeded, or in the event of an open switch. These functions are performed without any action being required on the part of the engineer or fireman.

Inside the engineer's cab are his signals, three electric bulbs which keep him constantly informed of the conditions ahead. One of these bulbs is marked "A." When it is lighted the engineer knows that he has a clear track for at least two full sections ahead. He is then free to run his train at any speed up to the maximum allowed for his Division. He cannot exceed this maximum speed, however, because if he attempts to do so the air brakes will be automatically applied. Hence the maximum speed rule cannot be broken even if an engineer should attempt to do so.

The next light is marked "R." When it burns the engineer knows that he has one clear section ahead, but that there is another train or open switch somewhere in the second section ahead. This light is the signal for medium speed and while it burns the automatic mechanism holds down the velocity of the train to whatever limit is fixed as "medium speed" on the Division in question, for instance, thirty miles per hour. This speed the engineer cannot exceed even should he so attempt, as the brakes will be applied.

The third bulb is marked by the letter "S" and is a "slow" or "stop" signal as conditions require. The indication from this signal is given at a point about 1,800 feet before the train reaches a section occupied by another train or having an open switch. If this light burns, and the engineer takes no action, the train control devices will apply the air brakes and bring the train to a complete stop. If, however, the engineer "acknowledges" the signal, by throwing a lever provided for that purpose, he can proceed at "slow speed" with his train under perfect control. The limit of "slow speed," as in the case of "high" and "medium," is fixed at different rates for different divisions, but when the "slow" signal burns, the speed determined for that particular division cannot be exceeded.

The outstanding advantages of automatic train control system are two in number:

1. It keeps the engineer in continuous touch with conditions ahead, as he carries the signals with him in the engine cab. With visual signals, on the right of the way, the engineer is in touch with conditions ahead only when passing the signals, which may be one to five miles apart.

2. It "plays safe" in the event of man-failure and brings the train safely to a stop, even should the engineer completely fail to do his part. In the event of sickness, injury or death of the engineer, it brings the train safely to a stop.

In addition, it is hoped that under automatic control it will be found possible to operate over a given stretch of track, without danger or interference, more trains than can be handled with the existing forms of dispatches or signalling. This, however, remains to be demonstrated.

A final provision for insuring safety lies in the fact that should the train control system itself become deranged, as for instance through the failure of the track circuit, the effect will be to bring to an immediate stop all trains on the portion of the track involved.

The Lewistown Branch, on which the tests are being made, is chiefly single track. The automatic train control on this branch is supplemented by visual signals at intervals of five miles. The purpose of these signals is not so much to guard against collision as it is to keep opposing trains from going past points at which sidings exist for passing purposes; also to provide means for delivering orders in case of necessity.

To complete the experiment, these supplemental visual signals on one half of the branch are designed to operate automatically in connection with the train control system. The signals on the other half are also operated automatically but in addition are under dispatcher's control.

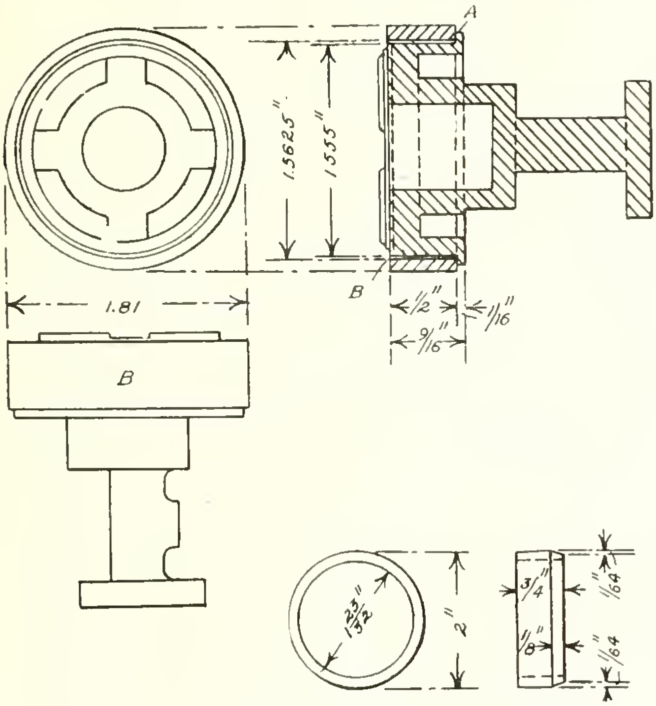
Railway Shop Kinks

Devices for Repairing and Testing Air Brakes

Method of Repairing Air Brake Feed Valve Piston and Bushing

It has been found to be much less expensive to repair slightly worn feed valve pistons and to put a bushing in the cylinder than to use new parts. The method here shown is one that has been adopted as a standard on a large trunk line.

The piston is turned off to a diameter of 1.555 in., leaving a small shoulder, at A, 1/16 in. thick. This leaves a seat ½ in. wide for the bushing. A brass bushing is turned to an inside diameter of 1.5625 in. with



Method of Repairing Feed Valve Piston and Bushing

an outside of 1.81, and is slipped on over the piston and soldered in place. A requirement being that the solder between the ring and the piston must show all of the way around the joint between the bushing and the shoulder.

The cylinder is bored so that a brass ring 2 in. in diameter and bored out to about 1 23/32 in. on the inside and ¾ in. long can be forced into it by a machine. This ring is tapered at one end, as shown, to a bevel of 1/64 in. so as to enter the cylinder. After it is in place it is machined to an inside diameter of 1 47/64 in.

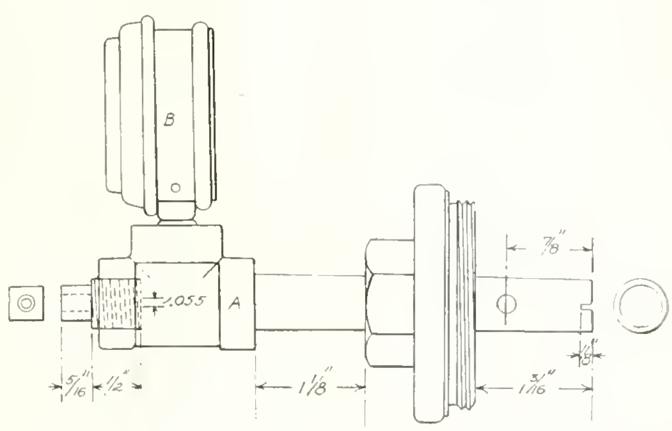
The ring *B* on the piston is then ground to a diameter .001 less than the cylinder.

Device for Testing the Leakage by the Supply Valve Piston on Slide Valve Feed Valves

This device is intended for use in testing feed valves on the Westinghouse standard feed valve test rack. It consists of a ¼ in. tee *A* into the top of which a 3 in. standard test gauge *B* is screwed. On one side of the tee there is a plug and a ¼ in. pipe is screwed into the other. This latter passes through a standard feed valve cap to the valve inside, and is attached to the stem of the valve.

The method of using it is this:

After the feed valve has been cleaned and lubricated, the flush nut, regulating valve and cap nut are applied. The feed valve should, then, be attached to the standard feed valve test rack, and the device attached to the feed valve. Open cocks *C* and *7* at the right, and close cocks *A* and *7* at the left as specified in the standard code for



Device for Testing the Leakage by the Supply Valve Piston on Slide Valve Feed Valves

testing feed valve. Regulating valve leakage can then be noted as one end of the valve is exposed. If the supply valve is leaking, it will be indicated by leakage at the port of the side of the regulating valve stem in the recess under the diaphragm. The leakage by the supply piston should either be noted on the gauge of the special testing device and the pressure shown on the gauge should not be less than 20 lbs. nor more than 60 lbs. If the pressure is less than 20 lbs. it indicates a tight piston, and if the pressure is more than 60 lbs. it indicates a loose piston.

Tools for Air Brake Repairmen

The tools illustrated by the accompanying engravings show a collection of small hand tools that are supplied by a well-known railroad to its air brake repairmen.

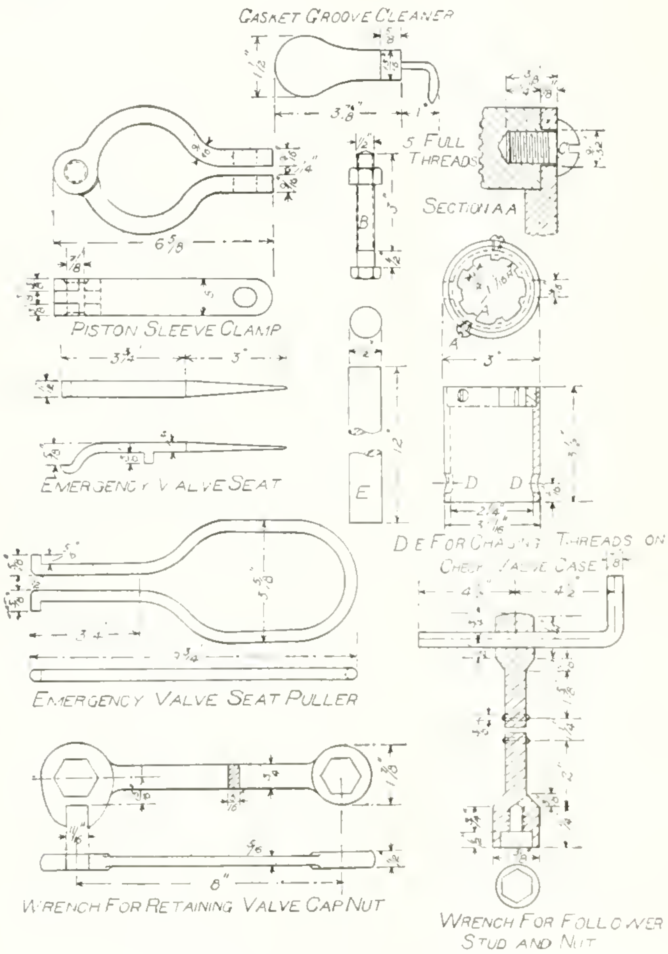
The upper one is called a gasket groove cleaner, and is a scraper used for cleaning out any remnants of packing that may adhere to the groove in the cylinder cap of a triple valve, when it is removed. It has a sharp point for working down into the corner of the groove and an edge for working over the flat surface of the seat for the gasket.

The piston sleeve clamp is made of two pieces of 9/16 in. by 1¼ in. steel bent to a radius of 1⅜ in. of the shape shown and with an oblong hole through the straight portion, by which they can be clamped over the piston sleeve of an air brake cylinder, by the bolt *B*, in order to hold it and the piston head, when work is to be done upon it.

The emergency valve seat lifter is a stout little lever that can be used to lift out the emergency valve seat by placing the heel on the edge of the check valve case, or in connection with the emergency valve seat puller. When the latter is used, the two legs with the L hooks at the end are put through the hole in which the emergency valve works and caught beneath the seat. Then a lever put through the loop and resting on the edge of the check valve case will serve to pull it out of the case itself.

The die for cutting 1¾ in. threads is set in the end of a tube of open hearth steel, and held in place by a machine screw *C*. This tube is 3½ in. long and has holes *D* 9/16 in. in diameter drilled through it near one end for the insertion of the ½ in. bar *E*, 12 in. long for turning it. The die is used for recutting or chasing the threads on the triple valve check valve case.

The wrench for retaining valve cap nuts has openings for three sizes of nuts, namely, ½ in. and ⅝ in. hexagon and ⅜ in. square. With a length of 8 in. it has leverage enough to loosen or tighten any of the retaining valve nuts.



Tools for Air Brake Repairmen

The last illustration is that of a socket wrench for the follower studs and nuts of the brake cylinder piston. Its dimensions are given in complete detail on the engraving.

Included with these special tools the following is the list of standard tools that are supplied to air brake repairmen:

List of Tools Furnished Air Brake Repairmen On Shop Tracks

No.	Tool	Remarks
1	Wrench for follower studs and nuts	
1	10 in. Stilson wrench	
1	14 in. Stilson wrench	
1	18 in. Stilson wrench	
1	24 in. Stilson wrench	
[illegible]	[illegible] in. by ½ in. S wrenches	For retaining pipe clamp
1	[illegible] in. wrench	For triple valve
1	[illegible] in. box wrench	For pipe plugs
2	[illegible] in. x ¾ in. S wrenches	
1	[illegible] in. wrench 4½ in. long	For removing triple valve
1	Hammer (machinist)	
1	Cape chisel	
1	6 in. cold chisel	
[illegible]	12 in. cold chisel	
[illegible]	[illegible] in. round brush	For soap suds
1	Gallon bucket	For soap suds
[illegible]	[illegible] in. round brush	For brake cylinder lubricating
1	[illegible] in. oak paddle	For entering brake cylinder leathers
1	Test gauge and fitting	
1	½ in. test bore and fittings	
1	Dummy coupler	
1	Set standard stencils	
1	Gasket groove cleaner	
1	One pint graphite bucket	
1	¾ in. brush	For graphite
1	1-16 in. drill	For cleaning blow-down port in retaining valve
1	No. 52 drill	For cleaning blow-down port in retaining valve
1	No. 54 drill	For cleaning blow-down port in retaining valve
1	Stub remover	For ⅜ in. pipe
1	Stub remover	For ½ in. pipe
1	Stub remover	For ¾ in. pipe
1	Stub remover	For 1 in. pipe
1	Stub remover	For 1¼ in. pipe
1	Tool box	
1	Grease measure	For air brake repairmen
1	Grease pail	For air brake repairmen

Tools to Be Furnished Air Brake Repairmen in Terminal Yards

No.	Tool	Remarks
1	10 in. Stilson wrench	
1	14 in. Stilson wrench	
1	24 in. Stilson wrench	
1	Hammer (machinist)	
1	8 in. cold chisel	
1	⅜ in. x ½ in. S wrench	
1	⅝ in. x ¾ in. S wrench	
1	Gasket groove cleaner	
1	Tool bag	

Tools to Be Used On Triple Valve Test Racks

No.	Tool	Remarks
1	T handle wrench	For removing cylinder cap
1	½ in. S wrench	For removing check case
1	Centering device	For triple piston
1	1 in. wrench	For triple valve union nut
1	6 in. monkey wrench	
1	⅜ in. box wrench	For pipe plug
1	Straightening device	For emergency valve
1	Leather protector	For brake cyl. packing leather
1	Triple valve check case thread die	For chasing triple valve check case threads

A number of these special tools have been illustrated in RAILWAY & LOCOMOTIVE ENGINEERING, as follows:

In the February, 1923, issue the centering device for triple valve pistons.

In this issue, the gasket groove cleaner and the die for the triple valve check case.

The Hardening of Steel

One of the most fascinating and yet obscure subjects in ferrous metallurgy concerns the problem of the hardening of steel by a suitable quenching treatment and a subsequent tempering of it by slight heating. The interest is centered around the hard constituent or structural condition, known as martensite, the name being derived from the noted German metallurgist, Martens. An investigation has recently been completed by the U. S. Bureau of Standards which has a bearing on this general subject, and Scientific Paper No. 452, entitled "Structure of Martensitic Carbon Steel and Changes in Microstructure which occur upon Tempering," details the result. Practically nothing is gained in hardness by using very high temperatures or very long heating periods prior to the quenching of steel, provided that the "critical" temperature is exceeded upon heating. The changes which take place in a hardened steel upon tempering occur in well-defined stages. Until the temperature of reheating exceeds 250 or 300 deg. C. (480 to 570 deg. F.), no marked change is to be noted in the visible microstructure, even at very high magnification, although pronounced changes in the dimensions and density often do take place even at such low temperatures. Above 250 deg. C. the separation of the carbon-bearing compound, cementite, from the martensite begins, and at 400 to 500 deg. C. (750 to 930 deg. F.) the steel shows a fine granular structure under the microscope. As the temperature of reheating is increased, all granules increase in size, although a high magnification is still required for seeing them, and the steel becomes softer and finally loses all of the high tensile properties it gained by the hardening treatment.

Autogenous Welding in the Firebox

The Bureau of Locomotive Inspection of the Interstate Commerce Commission has compiled a table, which is reproduced herewith, of the crownsheet failures in locomotive fireboxes for seven fiscal years commencing with the one ending June 30, 1916, and for the first nine months of the fiscal year ending June 30, 1923.

According to this table approximately 77 per cent. of autogenously welded seams involved in firebox failures have been torn, while only 15.9 per cent. of riveted seams involved in firebox failures have given away. The fatalities where the sheets tore have been seven and one-half times as great as where they did not tear. From July 1, 1915, to March 31, 1923, autogenously welded seams have been involved in 24.3 per cent. of the crownsheet failures, and 46.5 per cent. of the total killed in crownsheet accidents were killed where the autogenously welded seams were involved. This seems to indicate that the autogenous seam, as ordinarily made, is more liable to fail when a crownsheet comes down than the riveted seam.

In connection with this matter of autogenous welding the inspector has issued a number of reports of boiler failures of which the following are a few abstracts:

On February 28, 1923, a boiler on a prominent railroad was marked up to "calk all leaks in firebox." While the boiler was still under a pressure of about 105 lbs. per sq. in. and a boiler maker was engaged in calking a rivet in a seam of the back flue sheet, the rivet blew out, permitting scalding water and steam to escape from the rivet hole. This hole measured approximately 13/16 in. in diameter. Because of leakage, the sheet around rivet hole was badly deteriorated and wasted away. A crack extended from this hole to the bottom flue hole in the fourth row of flues from left side. This crack had been autogenously welded at some previous time, but the welding had cracked and was leaking prior to the accident, and due to this leakage, the flue had been worked many times in an effort to make it tight and a flue thimble had been applied which was in place at the time this investigation was made.

The rivet just above the one that failed was badly deteriorated, the head being practically eaten away by leakage, and the first and second rivets below the one that failed were also deteriorated and bore evidence of heavy calking. Autogenous welding had been applied around these rivet heads and practically covered what remained of the head of the rivet just below the one which failed.

There were nine rivets in the left side sheet running seam with the heads calked away and autogenous welding applied in an effort to stop leaks. A vertical crack 13 in. long in the right side sheet had been repaired by autogenous welding and two staybolt heads had been welded over at the lower end of the crack. There was also a crack 3 in. long in the right side sheet that had not been welded and had been leaking prior to the accident.

The calking edge of the flue sheet had been autogenously welded for 8 in. This welding was applied to stop leakage and to build up the badly deteriorated sheet in the immediate vicinity of the rivet that blew out.

A boiler exploded on the Southern Railway on January 21, 1923, the force of which tore the boiler from the frame and hurled it forward for a distance of 165 feet.

The boiler was of the extended wagon top type with a radial stayed firebox and combustion chamber. The crown and side sheets were of one piece construction.

TABLE I

Statement showing relative effect of crown sheet failures in which the sheets pocketed only, with those in which the sheets ruptured

Years ended June 30—	1916			1917			1918			1919			1920			1921			1922			First 9 Months 1923			Totals			Killed Per Acci.	Injured Per Acci.
	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I		
Total number of crown sheet failures......	41	20	64	63	45	100	90	32	149	67	39	113	61	41	83	53	45	76	27	21	50	46	32	73	448	275	707	.61	1.58
Total accidents in which the sheets pocketed, but did not tear....	29	5	43	42	3	66	63	6	105	35	5	70	30	6	44	29	8	46	15	4	33	23	4	38	266	46	447	.17	1.68
Total accidents in which the sheets tore	12	15	21	21	37	32	27	26	44	32	34	42	31	35	39	24	37	30	12	17	17	23	28	35	182	229	260	1.26	1.43

TABLE II

Crown sheet failures in which the riveted seams in firebox were involved in the accidents

Years ended June 30—	1916			1917			1918			1919			1920			1921			1922			First 9 Months 1923			Totals			Killed Per Acci.	Injured Per Acci.
	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I		
Total crown sheet failures in which the riveted seams were in the pocketed or ruptured area, or were subjected to unusual stress	35	18	57	40	32	60	51	17	88	28	14	54	30	23	39	23	28	33	15	16	23	28	28	44	251	176	398	.70	1.58
Total accidents in which riveted seams failed...	8	8	16	5	6	9	6	9	8	2	3	2	6	5	5	8	12	13	2	3	1	3	5	4	40	51	58	1.27	1.45
Total accidents in which riveted seams did not fail	27	10	41	35	26	51	45	8	80	26	11	52	24	18	34	16	19	20	13	13	22	25	23	40	311	128	340	.41	1.09

TABLE III

Crown sheet failures in which the autogenous welding in firebox was involved in the accident

Years ended June 30—	1916			1917			1918			1919			1920			1921			1922			First 9 Months 1923			Totals			Killed Per Acci.	Injured Per Acci.
	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A	K	I		
Total crown sheet failures in which the welded seams were in the pocketed or ruptured area, or were subjected to unusual stress	2	2	2	5	11	12	10	11	18	22	22	29	22	26	28	20	25	30	8	10	11	20	21	31	109	128	161	1.17	1.48
Total accidents in which welded seams failed...	2	2	2	4	9	3	9	11	17	15	18	21	17	20	22	16	24	22	8	10	11	14	16	24	85	110	122	1.30	1.44
Total accidents in which welded seams did not fail	..	..	..	1	2	9	1	..	1	7	4	8	[illegible]	6	5	4	1	8	..	..	..	6	5	7	24	18	39	.75	1.62

A = Accidents. K = Killed. I = Injured.

The seams in the door hole and at the bottom of combustion chamber sheet, as well as the seam between the crown sheet of combustion chamber and firebox proper, were autogenously welded while all other seams were riveted.

The crownsheet had been overheated over an area 127 in. long and 68 in. wide.

The initial rupture apparently took place in the autogenously welded seam between crown sheet of combustion chamber and firebox proper. This seam failed for a distance of 42 inches.

On February 2, 1923, a locomotive boiler exploded on a railroad in the Southwest. An investigation disclosed that the crownsheet had been overheated, and that it pulled away from all of the radial stays, and the side sheet pulled away from 257 staybolts. The right side sheet tore diagonally from a point near the flue sheet between the 5th and 6th rows of crown stays to the right of center down to a point in the welded seam of patch, which was 32 in. above the mudring and approximately 16 in. back of flue sheet. The tear then followed the welded seam for a distance of 18 in., then through side sheet for a distance of 7 inches, then again followed the welded seam back to a point 30 inches from the door sheet seam, and then diagonally up to top of door sheet.

On March 10, 1923, an accident occurred to a locomotive boiler while it was hauling a passenger train at a speed of 35 miles an hour.

A crack in the right side of the boiler back head which had been repaired by the autogenous welding process suddenly failed, emitting steam and water with sufficient force and volume to so scald the engineer as to cause his death and disabling the fireman.

The force with which the scalding water and steam escaped through the rupture compelled the engineer to leave the cab without being able to close the throttle or apply the brakes in order to stop the train in the usual way.

The investigation disclosed that on April 13, 1921, a crack in the right side of boiler back head was repaired by the autogenous welding process. The welding had been reinforced and covered an area of 3½ in. wide by 25¾ in. long. Soon after this another crack developed 2¼ in. to the right, 13 in. long, and parallel to the original crack. The latter crack was also repaired by the autogenous welding process at a later date, not definitely established, but it appears from such information as we were able to obtain that this repair was made on or about April 14 or 15, 1921, soon after the first crack developed. It was the latter crack which failed, causing this accident, which indicates that the welding had been done approximately 23 months prior to failure. When the failure occurred the crack extended ¾ in. at the bottom and 7¾ in. at the top, making a total length of 21½ in.

On February 22, 1923, a staybolt had been reported as leaking, and an examination disclosed that a crack 8 in. long on the left side of boiler back head, which had been repaired by the autogenous welding process, had opened up. Repairs were then made by applying a patch 23 in. in length and 7¾ in. wide over the crack.

In connection with the report of this accident the chief inspector, Mr. A. G. Pack, called attention to two previous accidents of the same kind, and closed the same with the following statement of the position of the Bureau in regard to the use of autogenous welding:

"These and other similar accidents which have occurred are conclusive evidence that repairs of this nature should not be permitted except where the welding is covered by a patch properly applied, which will prevent such accidents in case of failure of the welded seam.

"It is impossible to estimate the serious results which might follow an accident of this nature to a fast-moving passenger train or any other train where the enginemen are forced to leave the cab without being able to close the throttle or apply the brakes, thus leaving the train to proceed uncontrolled.

"The autogenous welding process is practically in its infancy, and, due to my desire to avoid hindering progress or the development of any process of such great value when properly and discreetly used, I have hesitated to ask this commission to establish or approve rules or regulations restricting its use in making repairs to the various parts and appurtenances of the locomotive or tender, including the boiler. However, unless it is confined to parts and appliances where through failure accidents and injuries will not result we will be compelled to adopt some restrictive measures in the very near future, in accordance with the essential provisions of the law.

"The many investigations of autogenous welding failures have clearly established its unreliability where it is subjected to severe strain, vibration, and shocks. We have said on many occasions that, due to its unknown value in advance of failure, it should not be used on any part of the boiler where the strain to which the structure is subjected is not fully carried by other construction which conforms to the requirements of the law and rules, including arch or water-bar tubes, stay bolts, crown stays, and boiler braces, or on other parts of the locomotive or tender, where, through failure, the loss of life or limb might result."

This portion of the report may be regarded as a cautionary notice to the railroads. There is no desire on the part of the Bureau of Safety to ask for an order restricting the use of autogenous welding other than those imposed by the present regulations. But it should be borne in mind that for a number of years the Bureau has taken the position that autogenous welding should not be permitted on any part of the boiler where the stress to which the structure is subjected is not carried by other construction which fully meets the requirements of the law and rules. These prohibit the use of any method of repairing on a locomotive or tender, including the boiler, where is can be shown that an improper and unsafe condition is created.

Without promulgating any set of rules governing the use of autogenous welding, the attempt has been made to restrict its use to parts and appliances of the locomotive where, through failure, accident and injury would not occur, and to avoid its use on those other parts and appliances which are subjected to severe stress or shock and where accidents and injuries might result in case of a failure. The attitude of the Bureau is, therefore, one of disinclination to interfere, but unless autogenous welding is used with greater care by the railroads than has been the practice heretofore, there is a possibility that the Bureau may be forced to ask for an order restricting its use.

This is a very serious matter. Restrictive laws are usually enacted to do away with abuses, and it is only after the stench of an abuse rises to heaven that the law forbids its practice. Autogenous welding can undoubtedly be performed in a manner that will satisfy the requirements of boiler practice. But the work has to be carefully done. Scamped work spells disaster, and if it is permitted to be done, and the Bureau finds itself forced, against its inclination, to issue an order forbidding its use on locomotive boilers, the railroads will find themselves deprived of a very economical method of making boiler repairs. But if it is done the users will have only themselves and their own negligence to blame.

This should be a warning to any who authorize or permit improper or unsafe welding of any character.

Notes on Domestic Railroads

Locomotives

The California Western R. R. & Navigation Co., has ordered 1 switch engine from the Baldwin Locomotive Works.

The Lakeside & Marblehead R. R. has ordered 1 switch engine from the Lima Locomotive Works.

The Richmond, Fredericksburg & Potomac R. R. has ordered 2 Pacific type locomotives from the Baldwin Locomotive Works.

The Toronto, Hamilton & Buffalo Ry. has ordered 2 Pacific type locomotives from the American Locomotive Company.

The Norfolk & Western Ry. is inquiring for 10 tender tanks of 15,000 gal. capacity.

The Kanawaha & Hocking Coal & Coke Company, Cleveland, Ohio, has ordered 1 Mikado type locomotive from the Baldwin Locomotive Works.

The Public Service Corporation of New Jersey is inquiring for a 6 wheel tank switching locomotive.

The Penssylvania R. R. is reported to have placed an order with the Westinghouse Electric & Manufacturing Co., for motors and control apparatus to equip 3 new type electric locomotives.

The Savannah & Atlanta Ry. has ordered 1 Mikado type locomotive from the Baldwin Locomotive Works.

The Richmond, Fredericksburg & Potomac R. R. has ordered 2 Mountain type locomotives from the American Locomotive Company.

Passenger Cars

The Lake Erie & Western R. R. is having steel center frames and axle lighting equipment installed on 15 coaches in its shops at Stoney Island, Chicago.

The Missouri Pacific R. R. Co. has ordered 18 coaches, 12 chair cars and 10 baggage cars from the American Car & Foundry Company, and 9 divided coaches, 3 cafe club cars and 8 dining cars from the Pullman Company.

The Erie R. R. Co., contemplates buying 6 all steel through line coaches and 38 all steel suburban coaches.

The New York Central R. R. Co., is making repairs to 10 coaches in the Collinwood shops. The improvements include putting steel underframes on these coaches.

The Erie R. R. is reported to have issued an inquiry for 400 suburban coaches.

Freight Cars

The Wabash Ry. has ordered 75 steel underframes for freight cars from the American Car & Foundry Company.

The Roxanna Petroleum Company, St. Louis, Mo., is inquiring for 350 tank cars.

The Chicago & North Western Ry. has ordered 50 center constructions for freight cars from the Western Steel Car & Foundry Company.

The Union Pacific Railroad contemplates buying 250 tank cars.

The Lake Superior & Ishpeming Ry. is inquiring for 200 steel ore cars of from 50 to 75 tons capacity.

The New York Central R. R. has given a contract to the Standard Tank Car Company for the repair of 500 all-steel hopper cars of 55 tons' capacity for the Pittsburgh & Lake Erie, and the converting of 500 old box cars to stock cars to the Standard Steel Car Company.

The Inland Steel Company is inquiring for 6 75-ft. flat cars.

The Alabama & Vicksburg Ry. is inquiring for from 100 to 200 box cars of 40 tons capacity; 100 to 200 flat cars of 50 tons capacity and from 100 to 200 gondola cars to be of 50 tons capacity.

The Atlanta & West Point R. R. will rebuild 75 box cars in its own shops at Montgomery, Ala.

The Standard Oil Company of New Jersey has ordered 10 center bottom dump cars from the American Car & Foundry Co.

The Philadelphia & Reading Ry. has arranged for the repair of 500 steel hopper cars with the Standard Steel Car Company, at Middletown, Pa.

The Mountour Railroad is in the market for from 300 to 500 hopper cars of 55 tons' capacity.

The Chesapeake & Ohio Ry. is inquiring for three refrigerator cars of 30 tons' capacity for carrying milk.

The American Smelting & Refining Company is inquiring for 2 dump cars of 50 tons capacity.

The Union R. R. is reported to have purchased 20 flat cars from the Standard Steel Car Company.

The Union R. R. is said to have ordered 10 tank cars from the American Car & Foundry Co.

The Cambria & Indiana R. R. has placed 300 steel hoppers for repairs with the American Car & Foundry Co.

The Pittsburgh & Lake Erie R. R. is reported to have placed for repairs 500 gondola cars with the Standard Tank Car Co.

The Chicago & North Western Ry. is reported as having ordered 1,000 stock cars built by the General American Car Company.

The Cambria & Indiana R. R. is inquiring for 2 cabooses.

The Norfolk & Western Ry. is inquiring for prices on the repair of 1,000 hopper cars of 57 tons' capacity.

The International Harvester Co. has entered the market for 10 billet cars.

The New York Central R. R. will have repairs made to 500 box cars by the Ryan Car Company and 200 box cars by the American Car & Foundry Company.

The Lehigh & New England R. R. comtemplates buying 6 or 8 cabooses.

The New York Chicago & St. Louis R. R. has ordered 100 steel underframes for box cars from Pressed Steel Car Company.

The Chicago & Alton R. R. is inquiring for 350 steel gondola cars, 250 steel composite gondola cars and 250 automobile cars.

The San Antonio & Arkansas Pas. Ry. is in the market for 25 automobile cars.

The Philadelphia & Reading Ry. has arranged for repair of 200 steel hopper cars with the Pressed Steel Car Company.

The Canadian National Rys. has ordered 1,000 automobile cars from the Pressed Steel Car Company.

The Pere Marquette Ry. has ordered 300 steel underframes for refrigerator cars from the Pressed Steel Car Company. These cars are to be built in the railroad company shops.

The Chesapeake & Ohio Ry. is said to be contemplating having repairs made to 1,500 steel cars.

Swift & Co., Chicago is reported to have issued an inquiry for 1,000 steel underframes.

Building and Structures

The Louisville & Nashville R. R. has prepared tentative plans for enlargements in its locomotive shops at Albany, Ala.

The Piedmont & Noorthern Ry. Shops at Greenville, S. C., were recently destroyed by fire.

The Pere Marquette has awarded a contract to the Arnold Company, Chicago, for the construction of a 16 stall brick roundhouse and the installation of a 100 ft. turntable at Erie, Mich.

The Lake Erie & Westeern R. R. has authorized the construction of improvements and additions to its shops at Lima, Ohio, at a cost of approximately $150,000. When the new facilities are completed the Lima shops will be the largest repair shops on the consolidated Nickel Plate system.

The Kansas City Southern Ry. Co., will rebuild its car repair shop at Shreveport, La., which was damaged by fire on July 11, with a loss estimated at $125,000 including equipment.

The Chicago & Alton R. R. has prepared plans for the construction of a new engine house and repair shops at Ridgely, Ill.

The Chesapeake & Ohio Ry. has tentative plans for the construction of a new engine house and repair shop at Peru, Ind.

The Atlantic Coast Line R. R. is reported to have completed plans for the construction of repair shops at Montgomery, Ala. A contract has been let to the Kershaw Contracting Co. for the excavation work, and the construction contract will be let early in September.

The Atlantic Coast Line R. R. announces that construction work will begin shortly on a series of new shop buildings at Rocky Mount, N. C., an investment of approximately $500,000 being planned. 500 new homes will also be erected at Rocky Mount to take care of the workers who will be employed in the shops when completed.

The Lehigh & New England R. R. is contemplating the erection of a 14-stall roundhouse at Tamaqua, Pa.

The Piedmont & Northern Ry. plans to rebuild the portion of its locomotive shops at Greenville, S. C. recently destroyed by fire.

The Pennsylvania R. R. is reported to be preparing plans for additions to its locomotive shops at Olean, N. Y., to replace the portion of the works destroyed by fire. The expansion will include a machine shop, erecting shop, power equipment and ash-handling apparatus.

The Elgin, Joliet & Eastern Ry. is reported to be taking bids for the construction of a one-story car repair shop at East Joliet, Ill.

The Union Pacific R. R. has acquired extensive property in eastern section of Los Angeles for extensive terminals and shops. The shop buildings will consist of the following structures; Brick roundhouse, 20-stalls, 105 feet deep; steel turntable 100 ft. Locomotive erecting and boiler shop with engine pits, combination wood and steel roof trusses with galvanized corrugated iron sides and roof, 195 ft. by 254 ft. including steel runways for traveling cranes. Coach; steel car and blacksmith shop with combination wood and steel roof trusses with galvanized corrugated iron sides and roof 155 ft. by 342 ft. Car repair shop with combination wood and steel roof trusses with galvanized corrugated sides and roof 80 ft. by 281 ft. Steel transfer table 92 ft. Power house 40 ft. by 114 ft. Oil house 28 ft. by 62 ft. Two story store house 42 ft. by 252 ft. Hospital building equipped with modern medical and surgical appliances. Various other buildings required in connection with the operation of a large terminal. Contracts have been let for most of these improvements which will cost several million dollars. The plant is to be completed by January 1, 1924.

The Chicago, Burlington & Quincy R. R. has contracted with the Graver Corporation, East Chicago, Indiana, for erection of a 15,000 gallon per hour Type "K" Graver Water Softener at contracted for by this road during the past month.

Supply Trade Notes

John R. Hayward has been appointed southern representative of the **Davis Brake Beam Company,** Johnstown, Pa. Mr. Hayward's headquarters are located at the First National Bank building, Roanoke, Va.

The American Brake Shoe & Foundry Company, New York, has purchased a four-acre site in North Kansas City, Mo., where it will manufacture brake shoes and iron castings. The construction of the building will be completed by the fall.

The Union Railway Equipment Co. announces the discontinuance of its Montreal office; hereafter all Canadian business will be handled by the Chicago office.

The Central Brake Shoe & Foundry Co., Chicago, incorporated under the state laws of Illinois, has opened a sales office at 247 Railway Exchange building, Chicago. The officers of the company are **F. Van Inwagen,** president **A. C. Deverell,** vice-president and **R. E. Frame,** vice-president. Mr. Van Inwagen was recently connected with the Corn Exchange Bank of Chicago and prior to that time was in the manufacturing business. Mr. A. C. Deverell was formerly general superintendent of motive power of the Great Northern Railway and of recent years western sales manager of the Locomotive Stoker Company with office at Chicago. Mr. R. E. Frame has been associated with the car building industry for a great many years. He was manager of sales for the Haskel & Barker Car Co., at Michigan City, Indiana, and later sales agent for the Pullman Company. The Company's plant is located at Clearing, Ill.

American Steel Foundries, Chicago, have completed plans for the purchase of the **Damascus Brake Beam Company,** Cleveland, Ohio, the former exchanging $1\frac{1}{2}$ shares of preferred stock for each share of Damascus common stock.

John L. Gould has joined the staff of railway sales department of **The Texas Company** with headquarters at 17 Battery place, New York City. Mr. Gould was formerly master mechanic of the Wilmington and Philadelphia Traction Company.

The Aluminum Company of America announces a change of their Chicago address. They are now located at 360 North Michigan Blvd., having moved from the Westminster Bldg.

J. Leonard Replogle, president and chairman of the executive committee of the **Vanadium Corporation of America,** New York, has resigned on account of ill health. Mr. Replogle remains as a director of the corporation.

V. Villette, mechanical expert, Pacific district of the **Westinghouse Air Brake Co.,** has been promoted to representative of the **Westinghouse Air Brake Co.,** and the **Westinghouse Traction Brake Co.,** same district.

Westinghouse Air Brake Co., announces that **A. C. Layton,** formerly a locomotive engineer on the Los Angeles division of the Southern Pacific, succeeds V. Villette as mechanical expert.

H. W. Johnston, service engineer, is a recent addition to the staff of the **Franklin Railway Supply Company, Inc.,** New York. Mr. Johnston was born in Kentucky in 1883, attended the public and high schools, and was graduated from the Kentucky State University in 1904, with the degree of B. M. E. After a special apprenticeship with the New York Central at Cleveland, Ohio, he was promoted to shop order foreman, general piece work inspector, and assistant shop inspector. He then went with the Delaware, Lackawanna & Western as assistant general foreman, reorganizing and getting under way the new shops at Scranton, Pa. He was later made supervisor of machinery and tools over the system. In this position he installed a central tool manufacturing department and service, which was extended to all shops and roundhouses. He later went with the Baltimore & Ohio, reporting to General Superintendent of Motive Power. For the Baltimore & Ohio he installed a system similar to the one which he had put in on the Delaware, Lackawanna & Western. Mr. Johnston has also had considerable experience in the industrial field.

A. C. Steinmetz is now a Service Engineer of the **Franklin Railway Supply Company, Inc.,** New York. Mr. Steinmetz began as a fireman on the Cleveland Division of the C. C. C. and St. Louis Railroad, and was later promoted to engineer. As a member of the Brotherhood of Locomotive Engineers, he has held positions of responsibility in that organization.

A. N. Willsie has been appointed western sales manager of the **Locomotive Stoker Company,** with headquarters in Chicago, Ill., to fill the position recently vacated by A. C. Deverell, who has resigned to go into business for himself. Mr. Willsie started his railroad experience in the master mechanic's office on the Chicago, Burlington & Quincy in April, 1880. He worked in various capacities with the Burlington for 39 years, serving consecutively in the office of the timekeeper, locomotive shops, car shops, and later became locomotive fireman and locomotive engineer and road foreman of engines. He was then division master mechanic, also division superintendent, and for a number of years filled the position of supervisor of fuel economy at the general office in Chicago until he entered the service of the Locomotive Stoker Company as district engineer, which position he held up to the time of his appointment as western sales manager.

J. P. Moses has been appointed general manager of railroad sales for **Joseph T. Ryerson & Son, Inc.,** with headquarters in the Illinois Merchants Bank building, Chicago. **H. T. Bradley** has been appointed manager of eastern railroad sales with headquarters at 30 Church street, New York City. **H. A. Gray,** formerly manager of railroad sales, has resigned to enter a new field.

Phillip X. Rice, instructor in railway electrical engineering and research engineer at the Pennsylvania State College, has been appointed electrical engineer of the **Miller Train Control Corporation** with headquarters at Danville, Ill.

The Flannery Bolt Company, Pittsburgh, Pa., has appointed the **W. S. Murrian Company** with offices in the Johnson Bldg., Nashville, Tenn., as its southern representative.

E. F. Boyle, Monadnock Bldg., San Francisco, Calif., has been appointed Pacific Coast representative of the **Grip Nut Company,** Chicago, and **J. L. Stephenson** Munsey Bldg., Washington, D. C., has been appointed representative for the same company on certain roads.

W. C. Reich, has been appointed assistant purchasing agent of the **Westinghouse Air Brake Co.** Mr. Reich has been employee of the company since October, 1902.

Graham Bright, formerly General Engineer in charge of the Coal and Metal Mining Activities of the **Westinghouse Electric & Manufacturing Company,** has joined the firm of Howard N. Eavenson & Associates, Mining Engineers of Pittsburgh, Pa. Mr. Bright will give special attention to power house systems, power plant appraisals, transportation and transmission systems for coal and metal mines, and general industrial power applications.

F. A. Wilson-Lawrenson has resigned his executive positions with the **Union Carbide and Carbon Corporation** and its various subsidiaries, with which he has been connected since 1917, for the purpose of making an intensive study of economic and business conditions in Europe and Asia, covering a period of several months. Application to his heavy duties as vice-president in charge of sales of the Prest-O-Lite Company, Inc.; of the National Carbon Company; of the American Eveready Works, as well as in other capacities, have made it necessary for Mr. Lawrenson to conserve his health, which his devotion and strenuous work on behalf of public and civic enterprises has somewhat impaired. The change of interests involved in the extensive travel abroad that he has planned will give him, it is thought by his medical advisers, the much-needed relief.

The Flannery Bolt Company has announced the resignation of Mr. R. W. Benson as Eastern Representative of the Flannery Bolt Company and the closing of their Eastern Office at 41 East 42nd street, New York City.

Items of Personal Interest

W. A. McCafferty has been appointed master mechanic of the Central of Georgia with headquarters at Columbus, Ga.

A. M. Lawhon has been appointed master mechanic of the Southern Railway at South Richmond, Va., succeeding **W. H. Owens** assigned to other duties.

B. H. Smith has been appointed acting master mechanic of the Rock Island System with headquarters at Estherville, Ia., succeeding **P. Linthicum,** granted leave of absence on account of ill health.

C. L. Starr has been appointed assistant road foreman of engines of the Baltimore & Ohio, with headquarters at Willard, Ohio.

J. B. Rogers, formerly road foreman of engines on the

Gulf, Mobile & Northern, has been made general foreman with headquarters at Louisville, Miss.

Frank Fisher has been appointed roundhouse foreman of the Chicago & Northwestern with headquarters at Hawarden, Ia.

J. A. McGinnis has been appointed roundhouse foreman of the Santa Fe with headquarters at Belen, N. M.

George W. Kern has been appointed roundhouse foreman of the Grand Island Railway with headquarters at Grand Island, Nebr., succeeding **J. J. Horrigan** who has been appointed general foreman with headquarters at Kansas City, Kans.

F. C. Chenoweth has been appointed superintendent of the car department of the Rock Island System, succeeding **J. H. Milton**, who has been appointed general foreman of the car department at Chicago.

J. D. Heyburn, general road foreman of equipment of the Frisco System has been appointed master mechanic at Fort Smith, Ark., succeeding **Charles Manley**, retired.

H. S. Rosser has been appointed master mechanic of the Norfolk Southern R. R., with headquarters at Norfolk, Va., succeeding **D. Patterson** who has resigned on account of ill health.

H. W. Johnson has been appointed superintendent of motive power and rolling stock of Minneapolis & St. Louis Railroad with headquarters at Minneapolis, Minn., succeeding **William Gemlo**, resigned.

Lee Chapman has been appointed assistant superintendent of motive power and rolling stock of Minneapolis & St. Louis Railroad with headquarters, at Minneapolis, Minn.

C. B. Rogers has been appointed master mechanic over the entire system of the Minneapolis & St. Louis Railroad with headquarters at Marshalltown, Iowa, succeeding **L. D. Brown**, resigned.

Obituary

Waldo H. Marshall, who was president of the American Locomotive Company from 1906 to 1917, died August 23, at his Summer home in Barnstable, Mass., at the age of 59, after an illness of about a week. His wife died a few months previously. A son and daughter survive.

Mr. Marshall had a wide and varied experience and held positions in the motive power and the operating departments of several large railroads. Mr. Marshall was well known in technical journalism and was connected with one or two railroad papers in New York and Chicago, and in May 1897, he left the editor's desk and entered the service of the Chicago and North Western as assistant superintendent of motive power. Two years later the Lake Shore & Michigan Southern offered him the position of superintendent of motive power. That company, recognizing the fact that a successful motive power superintendent has in him the qualifications which go to make up the equipment of an efficient operating officer, transferred Mr. Marshall to the general superintendent's chair in 1902, and the following year advanced him to the position of general manager. The passenger 2-6-2 engines, known on the Lake Shore as Class J, were designed by Mr. Marshall while in charge of the motive power of that road. These engines were probably the first to be built with boilers having 19 ft. tubes, and altogether their general design marked an advance in locomotive practice in this country.

In 1917 upon his retirement as president of the American Locomotive Company, he became associated with J. P. Morgan & Co., and in January, 1918, he was appointed Chief of the Production Division of the Ordnance Department, U. S. A. Mr. Marshall had also been a member of the Naval Consulting Board, and of the Committee on Industrial Preparedness of New York, which made a State survey of industrial resources. He was chairman of the board and president of the Consolidated Machine Tool Corporation of America, a director of the American Brake Shoe and Foundry Company, the Bucyrus Company, and the Chatham and Phœnix Bank.

M. S. Montgomery, fuel supervisor of the Northern Pacific with headquarters at St. Paul, Minn., died in that city on August 8.

Edward C. Lalonde, senior inspector for the board of Railway Commissioners of Canada, died suddenly at Moncton, N. B., on August 1.

George L. Harvey, who was an early designer of steel cars and the inventor of the Harvey friction draft gear spring, died in Chicago on August 13.

George A. Nolpe, grand vice-president of the Brotherhood of Railway Carmen of American, died in Cincinnati, Ohio, on August 11.

New Publications

Fire Losses—Locomotive Sparks. By L. W. Wallace, executive secretary American Engineering Council of the Federated American Engineering Societies; former professor Railway Mechanical Engineering, Purdue University; 203 pages, 6 in. by 9, 111 illustrations, bound in leather. Published by Barr-Erhart Press, New York.

Very little has been published on the subject of risks and the fire losses due to locomotive sparks since Professor Goss embodied reports of his investigations conducted at Purdue University in his book Locomotive Sparks, and the report on the subject to the Railway Master Mechanics' Association of 1906.

In the book before us, the author has embodied reports of laboratory and road tests made since that time which adds materially to the available data on the subject both from a practical and scientific standpoint and is the most complete analysis we have seen.

The question of fire losses, caused by or charged to railway locomotives, has been and is now a most important one to all those interested, and particularly those who have to do with the design, construction, operation and maintenance of locomotives, while the legal departments, courts, juries and witnesses have as a rule been pretty much in the dark as to certain fundamental facts which this book brings out so plain and clear that even "A Fool Could Not Err" in its meaning.

The extent and seriousness of fires originating along steam railways has raised a distinct question of responsibility and liability of railway companies for such fires. In all states the common law requirements basically make it necessary for railroads to exercise proper precautions to reduce fire hazards. However, many states, in more recent railway and conservation legislation, have included special provisions having the same object in view. Still other states which have created public utility and conservation commissions have empowered these commissions to exercise definite jurisdiction over railroads for the purpose of controlling the likelihood of fire from such sources.

This book should be in the hands of and carefully studied by every one who has to do with fire claims caused by or charged to steam locomotives as its careful persual would no doubt result in improvement in spark arresting apparatus in locomotives, and a reduction of perjured testimony in behalf of those who seek to collect fire losses from railways for which they are not responsible.

The book is well edited, the order of sequence being such as to retain the reader's interest in the subject up to and including the conclusion, and finally the author has in very fitting and appropriate language dedicated the work to Dr. W. F. M. Goss.

Westinghouse Railway Operating Data. The first five leaflets in volume two of its Railway Operating Data Series have just been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

This Railway Operating Data has been prepared by the Westinghouse Company for the use and assistance of electric railway operators in the care and maintenance of car equipment. The information is in the form of educational articles offering suggestions along labor saving lines in simple language easily understood by shop workmen. The methods suggested and described are those that have proved economical in well-managed repair shops.

The subjects treated in this issue of the series are: Railway Motor Shafts and Their Maintenance, Axle Collars, Gear Cases, Ventilated Railway Motors, Life of Axle Bearings of Railway Motors, and Heat Treated Bolts for Railway Service.

Copies of this publication and of volume one of the series may be had upon application to the Westinghouse Company.

Lubrication, From Tallow to Dearborn Oil. The Dearborn Chemical Company, 332 South Michigan avenue, Chicago, has issued a small but interesting booklet of 52 pages under the foregoing title, and which the company calls a frank attempt to guide the buyer away from the type of oils and greases, which while costing less per barrel, cost more per month or year both in quantity used and losses due to friction.

This booklet will be of considerable assistance to the purchaser of lubricating oils and greases in deciding which grades will be most effective in developing maximum power equipment efficiency. An interesting discussion of wet and dry steam cylinder lubrication is given. There are also chapters on steam turbine, uniflow engine, and air compressor lubrication. There is a chapter on laboratory control, with illustrations of testing equipment from photographs taken in the Dearborn laboratories. The closing chapter contains valuable information regarding laboratory control and methods of testing lubricants.

Golden Anniversary Catalog of the Industrial Works. The Industrial Works, Bay City, Mich., has issued an elaborate catalog descriptive of its line of locomotive and other cranes, and commemorating a half-century of the Company's existence. The catalog is divided in sections devoted to (1) locomotive cranes of rail, traction and crawling tractor types, and barge, wharf and gantry cranes; (2) crane accessories such as clam shell buckets, magnets and drag lines; (3) wrecking cranes ranging from 75 tons to 200 tons capacities; (4) special railway equipment such as pillar and transfer cranes, portable rail saws and transfer tables; (5) pile drivers, pile hammers, etc., and (6) facilities for foreign service.

Preceding the catalog sections is an interesting history of the development of cranes from the time of the Pyramids to the latest designs, illustrating and describing the various methods of hoisting, transferring and material handling. The catalog is profusely illustrated with photographs of the equipment.

New Thermit Rail Welding Pamphlet Issued. The Metal & Thermit Corporation, New York, has issued a new Thermit Rail Welding Pamphlet, which brings up to date the whole subject of Thermit Rail Welding to cover the many recent improvements in economy and efficiency.

The pamphlet includes detailed instructions, accompanied by illustrations and drawings, showing steps in making the improved Thermit rail weld which has greatly reduced the cost per joint. Improved apparatus used in connection with Thermit rail welding, such as the self-luting mold box and the new lightweight double-burner preheater, which have greatly accelerated the speed of operation, is described in detail for the first time, as well as illustrations showing results of a ten years' service test of the Thermit rail weld, also rail bending and drop tests. Instructions for using Thermit for welding compromise joints, constructing frogs and crossings and repairing loose arms of mates and switches, have also been included in complete form. At the end of the pamphlet is a discussion of the theory of rail joints.

G-E Completing Important Electrification Work

Important heavy electrification work for seven railroads is nearing completion in the Erie works of the General Electric Company.

Three 120,000-pound 600-volt freight locomotives are being prepared for shipment to the Bethlehem Chile Iron Mines. A special feature of these locomotives are four offset trolley poles, two on each side of the locomotive, for collection from trolley wires along the side of the track, used for manœuvring on docks close to the water edge. These units will also be equipped with two 600-foot cable reels for use on sidings or spurs and where no overhead trolley is available. They are of the steeple cab swivel truck type, length 37 ft. 4 in., height 11 ft. 11 in. They will also be equipped for dumping cars with compressed air.

Two 120,000-pound 600/1,500-volt freight locomotives for the Sacramento Northern Railway are now in assembly. These resemble the locomotives intended for the Bethlehem Chile order described above with the exception of the offset trolley poles and cable reels.

The largest order in process of manufacture includes ten 150-ton 3,000-volt locomotives for the Mexican Railway Company, Ltd. It is expected that the first of these will be ready for test about August 15.

High speed tests of the locomotive ordered by the Paris-Orleans Railroad are expected to be held next month. This locomotive, now nearly completed, will be a 120-ton machine of special construction, operating at 1,500 volts, with gearless motors and equipped with two 3-axle driving trucks, a 2-axle guiding truck at each end and 2 box cabs. It is 62 ft. long. Speeds in excess of 90 miles per hour are expected.

Shipment has just been made of two 120-ton 600-volt locomotives for the Baltimore & Ohio Railroad Company for the Baltimore tunnel. These are of the same general type as units now in service on this road. They are of the steeple cab type with articulated trucks and each equipped with G-E 209 motors. The length of the locomotives inside knuckles is 39 ft. 6 in., length over cab, 33 ft. 6 in., height over cab, 12 ft. 4 in., overall width 10 ft.

For the Toledo Edison Company, a swivel truck type switching locomotive with a 750-foot cable reel is being made. This will be equipped with multiple unit control and combined straight and automatic air brakes.

A 50-ton 600/1,200-volt locomotive is under construction on order of the Portland Railway Light & Power Company for the Willamette Valley Southern Railway.

Effect of Temperature on the Tensile Strength of Steel

It is so well known as to be almost absurd to mention it, that an increase of temperature of steel results in a decrease of tensile strength. But it is not so generally known that there is first a lowering and then an increase of strength during the early stages of heating. Naturally the content of impurities also has its effect. The first effect of the impurity of carbon is to increase the tensile strength as its own content increases.

In the table here presented we have the results of an interesting series of investigations on ten steels of different carbon and manganese content, in six of which the silicon content is also given as shown in the following table:

CHEMICAL ANALYSIS OF STEELS

No.	Carbon	Manganese	Silicon
1	.09	.11	
2	.20	.45	
3	.31	.57	
4	.37	.70	
5	.51	.58	.02
6	.57	.93	.07
7	.71	.58	.08
8	.81	.56	.17
9	.89	.57	.19
10	.97	.80	.28

First, by a comparison of the impurity content, as shown by the table, with the diagram of the tensile strengths, we see, as would be expected, that it is the carbon that is the controlling factor and that the effect of the manganese seems to be practically negligible.

If a diagram showing the impurities were to be laid out it would be seen that the carbon line rises in an almost straight line from steel No. 1 to No. 10, while there are wide irregularities in that of the manganese.

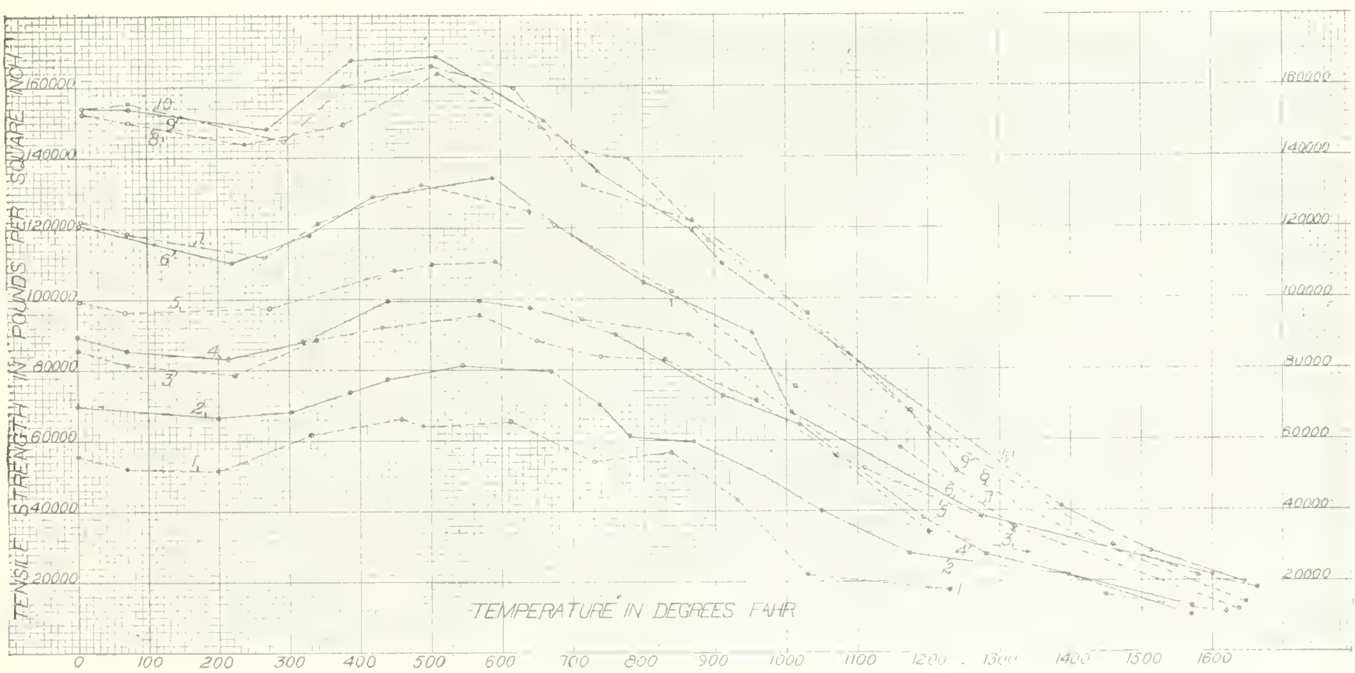
This even rise of the carbon makes it difficult to account for the grouping of the steels of the upper carbon content. For example, there is a difference of but six points between Nos. 5 and 6 and fourteen points between Nos. 6 and 7, and yet the lines of 6 and 7 lie close together throughout their whole extent. The same difficulty is encountered in attempting to account for the grouping of Nos. 8, 9 and 10. The most plausible explanation is that the methods of manufacture were not the same.

The low point of tensile strength varied from a temperature of 195° with No. 1 to 295° with No. 9. There is a general but irregular rise in the temperature of the low point in the curve as the carbon increases.

As for the temperature at the maximum tensile strength, this maximum is held by steel No. 1 having the lowest carbon content from about 460° to about 610°, a range sufficiently great to include the temperatures of the maximum tensile strengths of all of the other steels, except No. 4, whose maximum holds from about 440° to about 570°.

The average temperature at the maximum strength for all the steels is about 540°; and the average for the lowest, prior to reaching the maximum, is about 220°. So that it may be stated roughly, on the basis of these tests, that the tensile strength of ordinary steel is at its minimum at about the boiling temperature of water and that it reaches its maximum at about 550° Fahr.

After this last temperature has been reached there is a steady fall in strength as the temperature rises, until when 1600° or a cherry red heat is reached the strength has been pretty well lost, and there is an average strength of but about 13,000 lbs. with a range from 5,000 to 20,500 lbs. per sq. in.



Curves Showing Effect of Temperature on the Tensile Strength of Steel Bars

From a structural standpoint this is a matter of little importance, but it shows how steels, whose ultimate strengths range from 66,000 lbs. to 164,000 lbs. per sq. in., come together at these high temperatures.

While not shown by the curves, it is possible than another quality of steel may be indicated by it.

It is well known that all steel-cutting tools hold their edges better when heated above the temperature of the atmosphere than when worked cold. A razor shaves better if raised to a little above the blood temperature. A finishing tool will cut more smoothly when warmed and high speed steels need to be worked at very high temperatures to be efficient.

It is suggested that the characteristics of steels as shown by this diagram, from which the tensile strengths are seen to rise with the temperature to a certain point, show that at that temperature the resistance to wear, because of its greater tensile strength, is greater than at a lower temperature, with the result that its efficiency is greater at this temperature.

It would be a hazardous statement to make, and one that might not be made to hold water, to say that the cutting efficiency of a steel is greatest at a temperature where its tensile strength is the highest; but it appears as though there might be a connection between the two.

Instruction and Training of Employes on the Orleans Railway of France

As a result of the war, and the loss of many members of their supervisory forces, the railways of France have found that the level of skill of candidates for the positions of foremen and supervisors is very much lower than it was before the outbreak of hostilities, because of the cessation of training during that time.

The result has been the establishment of regular courses of training for employes in order to better fit them for their work.

In the May, 1923, issue of Railway and Locomotive Engineering an illustrated description was published of an instruction car that has been put into service on the Orleans Ry. This railway has also introduced elaborate courses of instruction for employes in the various departments. The purpose is to prepare men for advancement, and enable young men who have the ambition to do so to rise above mediocre positions.

The courses of instruction include night schools, the object of which is to improve the general methods of instruction, but without special preparation for any particular department, because such instruction can only be given at the principal centers on the system. Hence the correspondence system was adopted for the ordinary courses, because this was regarded as the only feasible method to be adopted with pupils so widely scattered and whose work was so irregular. The work has now been in progress about two years and is giving very satisfactory results.

Here are twelve complete courses.

The evening courses are open to all, with the exception of apprentices, who have studies during their working hours. Sessions are held twice a week from October to June, after working hours, from half past five until seven o'clock.

The general courses are as follows: 1, French, Arithmetic; 2, Geometry, Designing; 3, Technology of the Locomotive, Elements of Mechanics and Electricity; 4, Accounting and Office Organization; 5, French, Methodical study of French composition, and the rules of style; 6, Arithmetic; 7, Geometry; 8, Designing; 9, Course in Accounting; 10, Elements of Mechanics; 11, Elements of Electricity; 12, Technology of the Locomotive.

The connection between the teachers and pupils is maintained as follows:

Each month, at a regular date, the pupils receive the subjects to be studied, and instructions as to the duties that are to be performed. The pupils then make a monthly report on:

a. A package of leaflets of the course of study that had been sent them.

b. Two applications of the course of the studies to actual problems.

c. One report on a technical subject.

d. One drawing of a detail of the rolling stock.

The pupils return their tasks each month at a fixed date, and attach thereto any requests for further information which they think desirable, to which replies are sent by return mail. This maintains a continuous correspondence between teachers and pupils by which obscure points are elucidated and some palliation for the lack of personal contact between them is afforded.

But this instruction, the outside duties and the correspondence is not altogether sufficient and it is indispensable that it should be supplemented by verbal instruction and examination. The pupils are then examined, on an average of once every two or three months, according to a ruling established in advance by the special instructors, who take advantage of these examinations to give supplementary explanations regarding points of especial interest.

As this verbal instruction, which is considered a necessary supplement to the correspondence instruction, is complicated by the need of providing demonstrating apparatus for the examiners, plans and large scale drawings are made available for the study of the several principal parts of locomotives, freight and passenger cars, machine tools, hand tools, etc., in order that a concrete idea may be obtained of the explanations that are made.

Then, as the instructors evidently cannot carry all of this cumbersome material with them, and as the duplication of it at the different stations would be too much of a burden, the instruction car, already illustrated in these columns, was built to contain and carry them.

The courses thus mapped out are being followed by more than one hundred pupils belonging to the different departments of the service of Material and Traction such as the main shops, storehouses and repair yards.

Reorganization of Alsace-Lorraine Railways

One of the more difficult of the problems of adjustment which the French Parliament is called on to solve as the result of the re-incorporation of Alsace Lorraine into French territory is the relation of the Alsace-Lorraine railroads to the French railroad legislation. The possibility of operating the Alsace-Lorraine railroads directly by the state was at one time considered, but this plan has been rejected by the Committee on Public Works of the Chamber of Deputies which has now drawn up a proposal for a a new regime, after have heard at length the representations made by local interests. Under the plan now advocated the Alsace-Lorraine railroads will be operated by the Compagnie de l'Est, but upon a special account and under the direction of an office located at Strasbourg.

Amalgamation of India Railways

Following the recommendations of the Acworth committee's report, the government of India has under consideration the amalgamation of the East Indian Railway and the Oudh & Rohilkhand Railway. The former line serves the districts of western Bengal, Bihar, the United Provinces, and the Southern Punjab with approximately 2,900 miles of 5½-foot gauge track. The Oudh & Rohilkhand Railway serves the eastern and central districts of the United Provinces and has approximately 1,700 miles of 5½-foot gauge track. The present headquarters of the two lines are at Calcutta and Lucknow, respectively.

Convention of the Traveling Engineers' Association

31st Annual Meeting Most Successful in the History of the Organization

The thirty-first annual meeting of the Traveling Engineers' Association was held at the Hotel Sherman, Chicago, Ill., from September 11 to 14, inclusive. The president, Frederick B. Kerby of the Baltimore & Ohio Railroad presided, and in his opening address spoke in part as follows:

One year ago today all of our railroads were in the midst of one of the largest strikes in their history, during which the motive power and rolling stock reached a stage of the worst condition we have known for some time, and just at the time of the year when the business of the country was most in need of good equipment to handle their heavy business. But they have now recuperated and have handled the largest business in the history of the railroads. This was brought about by peace and the co-operation of all interests as well as by the energetic and economical management of the officials of the railroads, and of which the members of this association deserve some credit for the part they have taken in this good work.

The railroads loaded more than four million freight cars in both May and June of this year, although this was the heaviest traffic ever carried by American railroads in similar periods, the car shortage which had continued since the fall of 1922 was wiped out and has been replaced by a surplus.

Despite the record breaking movements, the number of freight cars in good repair and immediately available for use continued to increase, so that on July 31st a surplus of 76,453 serviceable freight cars was recorded. The surplus was attained in spite of the fact, that for the week ending July 28th, there were loaded 1,041,044 cars, the largest number for any week in the history of the country.

Efficiency of railroad operation probably never before equalled, or did this. Team work and co-operation among the railroads and the shippers, and between the men within the various organizations brought this about.

A plan of action was decided upon by the member roads of the American Railway Association and Association of Railway Executives early in the year and they decided on the following: 1. 89 per cent of locomotives in serviceable condition by Oct. 1, when the heaviest traffic season starts. 2. 95 per cent of freight cars in serviceable condition by Oct 1. 3. 30 tons of freight as the average car load. 4. 30 miles per day as average car movement.

The progress toward this goal, that has been made by the railroads in general in getting their motive power in the best condition. The railroads as a whole increased the number of serviceable locomotives from 75.9 per cent on January 1, 1923, to 83.8 per cent on July 1, almost to the 85 per cent goal, with 3 months more to make the other 1.2 per cent which they will do.

The railroads, as a whole increased the number of freight cars in serviceable condition from 90.5 per cent on January 1, 1923, to 91.6 per cent on July 1 with 3.4 per cent to make in 3 months, which they will do.

The Baltimore & Ohio Railroad, in the last data shown September 1, has reached 86.6 per cent of their motive power in serviceable condition and 95.7 per cent of their freight cars in serviceable condition, passing the goal and with one month more to go, and with the continued improvement as in the past 8 months, they will probably go far above the goal that was agreed upon, and I believe that there are other roads that are doing almost if not equally as well, but none better according to the records.

Progress made by the railroads in the repair of rolling stock is indicated by the fact that 38,000 repaired locomotives and cars were turned out by the railroad shops each month during the first six months of 1923, as compared with 21,000 per month during the same period last year.

The heavy loading of cars for all of the railroads increased from 27.8 tons in April to 26 tons in May, the last month for which complete data is available. This is the highest mark for any May since 1917. Goal is set for 30 tons.

Making progress towards 30 miles for freight cars per day, the railroads increased the average daily movement of freight cars from 27.9 miles in April to 28.6 miles in May, as compared with 22.7 miles in May, 1922, an increase of one mile in the average movement, this is equivalent to adding 100,000 freight cars to the Country's available car supply, and with the additional new locomotives and new cars that are now ordered and will be delivered by October 1, the railroads are in better condition to handle the increased traffic of our Country, than ever before in the history of American railroads, and gentlemen, we are a prime factor in accomplishing this work, and that is one of the reasons for our being here today.

The railroad official that does not feel that there is sufficient benefit derived from sending men to these conventions are not properly informed in the reports that you give to them on your return from the meetings, or he probably does not have time to read same, it may also be possible that the reports that you make out are not brief and to the point. I feel that any good official knows that he alone cannot operate a railroad and that he is only as strong as his organization and the organization is only as strong as he makes it.

Efficiency in railroad work is a matter of education and experience and is mostly obtained through the association of each other and exchanging the views of each other's experience, which is the object of this association.

Elsewhere in this issue are published the following papers that were read before the meeting: "Treatment of Feed Water for Locomotive Use and the Results of Same"; "Locomotive Feed Water Heaters"; and an abstract from the paper "Universal Brake Control Compared with Other Types of Brakes."

Reports were also presented as follows: How Can the Work of the Traveling Engineers be Made More Effective, and Can the Usual Number of Traveling Engineers Properly Take Care of the Duties Expected of Them"?

"What Advantage and Economy in Running Locomotives Over Two or More Divisions"?

This is not only an interesting and live subject for traveling engineers, but it is of such vital importance in the general scheme of operating economy that it materially broadens under treatment, bringing out many features of economy incident to terminal expense as well as the reduced interest charge on investment in equipment due to the less number of engines required.

A very interesting report was presented on the subject of "Automatic Train Control," which dealt with the development and the principal features of the various systems of train control.

"The Advantages of Fuel Oil for Locomotives," was the subject of the paper that dealt with improved operating conditions through the use of oil as fuel.

Treatment of Feed Water for Locomotive Use, and Results

Report of a Committee to the Traveling Engineers' Association

Treatment of water for use in locomotive boilers has been in effect on some railroads for many years and on an increasing number of railroads for the past twenty years. In that time a great variety of methods have been tried out; many have been discarded for the reason that results obtained were not satisfactory or that the expense involved more than offset any advantage gained. It may also be said that in numerous cases failure to realize results anticipated has been due to neglect by those responsible for application or seeing that instructions were followed.

Of the different methods employed for the treatment of locomotive feed waters, soda ash and lime is the oldest and most generally accepted. In the early days of the water treatment soda ash and other neutralizing agents were resorted to, but their use was left largely to the judgment of the various engine crews and terminal forces, resulting in many instances in improper treatment, causing formation of scale and foaming. Enginemen objected to this kind of treatment for the reason of so-called engine failures or man failures. Excessive blowing out of boilers had to be resorted to with corresponding fuel losses.

In those days after reporting for duty, enginemen thought nothing of blowing the boiler down after being filled to the stack, refilling and reblowing until two or three boilers of water had been blown away.

In some cases, enginemen were in the habit of putting in a heavy fire with blower working full, putting on one or possibly both injectors if blower was strong enough to hold up steam pressure, then opening blow-off cocks and blow the boiler out for several minutes. Water going into the boiler in this manner will flow in the direction of blow-off, becoming entrained due to the attraction of current and flow with the volume passing out immediately to the atmosphere. The effect on the boiler with this treatment was harmful and great fuel losses were entailed with no benefits as results.

Frequent blowing off was done when moving between stations and if the engine [illegible] or if direction of wind happened [illegible], the equipment got a coating of [illegible] the expense of cleaning passenger equipment [illegible] not included as an item of expense [illegible] treatment.

Locomotive efficiency is affected by the character of feed water furnished. A locomotive using pure clean water may run for long periods [illegible] or before any scale formation, enabling [illegible] dry steam on saturated and a higher temperature of steam on the superheated locomotive, resulting in a high engine efficiency and the lowest possible fuel costs.

Boiler feed water containing foaming impurities, if not properly treated, will not permit of economical operation of the locomotive on account of particles of water being frequently carried over into steam pipes, valves and cylinders, destroying lubrication, thus making it impossible to work the locomotive at the shortest possible cut off.

The same applies to superheated locomotives in that the superheater equipment is used as a steam generator instead of a steam drier, and instead of the foaming impurities being carried as a wet spray, they pass to the cylinders and valves in the form of a sand storm destroying lubrication and cutting packing rings and friction surfaces. The greater damage is done to the superheated locomotive on account of not being noticeable to the enginemen until the reverse lever handles so hard that in many cases it will jump out of the quadrant.

Feed water containing incrustating solids may not only affect the operation of any locomotive and will not affect the fuel performance of engines with new flues and fireboxes, but will cause excessive fuel consumption according to thickness of scale formation and will be quite noticeable on locomotives with excess mileage from date of last shopping.

The impurities found in water vary according to the source from which it is obtained. Therefore it should be subjected to a purifying treatment to either neutralize or remove the acids or incrustants that interfere with locomotive or boiler performance and maintenance.

Certain impurities, if left in the water, decompose the metal in the boilers and cause pitting, thus shortening the life of the boiler and at the same time prevent proper heat penetration of the heating surfaces, which results in excessive fuel consumption. Water is never found in an absolute pure state under natural conditions, as it will absorb and carry with it various impurities in its flow to wells or streams where it is obtained for use.

The topography of the country, location of streams, grades and the track conditions of the railroad make the location of water tank selection of boiler water a matter of necessity and not of choice.

It is often impossible after sinking deep wells, building reservoirs and piping the most suitable water at a large expenditure, both constructive and maintening, to secure a desirable or suitable supply for locomotive use; that is, a water free from impurities both vegetable and mineral, causing boiler troubles, decreasing the evaporation capacity and efficiency of the boiler as a steam generator by incrustation or chalking the heating surfaces of the superheater units, destroying cylinder lubrication, increasing boiler maintenance repairs and shortening the life of parts affected.

It is beyond doubt that there is no detail touching on the safety and economical operation of the locomotive that has been so grossly neglected as the matter of feed water [illegible] wasteful and dangerous properties, such as incrustants, corrosives, priming and foaming impurities. In fact, it is only of recent years that a great deal of attention has been given to the interior of boilers and many a boiler has been condemned as unfit for work to be performed on account of its reduced horsepower due to corrosion, resulting in inefficiency.

Ordinarily, water contains impurities that cause one or more of the following conditions: incrustation or formation of scale due to its calcium and magnesium, carbonates and sulphates, sodium chlorides and sodium sulphates and other impurities causing foaming.

Corrosive impurities are very destructive to the boiler and some of its appurtenances causing pitting, honeycombing and grooving. Especially will this be noticeable where metal is checked from flanging.

Several chemical or mechanical methods have been employed for the feed water treatment of the locomotive and which may be termed the interior and the exterior methods.

Care should be exercised in the selection of proper materials for feed water treatment, as a simple or compound article that would be beneficial in one kind of water may be inert or even deleterious when used with another.

In recent years outside treating plants of the soda ash and lime type have been installed on a good number of railroads. These involve the expense of plant installation, interest on investment, upkeep, material for treating water and labor. These plants are in many cases placed in the hands of men having no knowledge of what they are trying to accomplish or of the harmful effects of an overdose of treatment. Where such conditions obtain the mishandling of water treatment at one point may slow up the traffic movement over the entire district.

It is not intended to imply here that all locomotives would perform badly due to the foregoing cause, yet if one locomotive with boiler in foaming dirty condition gets an overdose the effect is that particular engine begins to fail, the dispatcher's figures do not stand up, delays to other trains occur and overtime makes up the expense that should be charged against feed water treatment. These are the conditions that obtain where the wayside treating plants are not properly handled.

The handling of feed water treatment on a railroad should be under the supervision of the Mechanical Engineer whose staff should include a number of experienced chemists that they could be in touch with the different water changing conditions of each water tank not less than once a week, and be given full charge of the handling of all employees handling feed water treatment. They should consult freely with locomotive enginemen in regards to the manner engines are carrying their water. They should have free access to wash-out records of all locomotives and should determine the time boilers should be washed—the present practice being to wash boilers on a mileage or calendar day performance, while the evaporation performance should govern.

The advantage of the wayside water treating plant is that proper amounts of chemicals may be used at each plant to meet the local conditions, thus changing the character of each separate water to the standard required or permissible for the territory involved, and can be successfully handled without undesired or erratic water action in the boiler, unless at certain periods or seasons of the year when streams are low, the low water may contain such quantities of hardness that unusual quantities of chemical are necessary to reduce the total hardness of the water to the required standard, in which case anti-foam compound may be used to prevent foaming.

On one particular line, the Kansas City Southern Railway, traversing a territory from the Missouri River to the Gulf of Mexico, has experienced a water condition encountered on only a few other roads and which has been the cause of excessive boiler maintenance costs on one part of the roads, namely, the first district and the terminal division where all engines are furnished water from the Missouri River. This water contains from eight to thirty grains of incrusting solids to the gallon, depending on the stage of the river.

From the locomotive engineer's point of view, this was a fairly good water for locomotive use and little difficulty was experienced with its handling; only at high water stage when water contained large quantities of animal and vegetable matter it caused foaming. No difficulty was experienced by the engineer during the low water stage of the river when the water was very hard and doing most damage to boilers, due to corrosion and pitting and therefore frequent failures from leaking and burst flues, requiring renewals of these parts. This, of course, results in excessive fuel consumption and often delay to switching in case of yard engines and delay to trains in road service.

In November, 1921, water treating plants were installed and put into operation at both terminals and five intermediate water stations on the first district and the handling of all plans turned over to the Mechanical Engineer, who assigned a chemist to look after the proper handling of each station, analyzing each water and prescribing the proper amount of chemicals necessary to reduce the hardness of the individual water to a predetermined consistency. Due to the frequent changing of the water in streams where water is obtained, it is the practice to make analysis of the water, both before and after treatment, at least once a week and change the amount of chemicals to meet the requirements.

The pumper or water tender was instructed as to the proper methods of handling each plant, such instructions being strictly complied with the water situation successfully handled for a period of ten months when failures began to develop from foaming. This resulted in some engine failures and delay to traffic and some of our traffic officials were inclined to place the cause of failures and delays on the feed water treatment, basing their conclusions on information furnished them by enginemen. Each failure reported was investigated and in each case we found the failure to be the result of improper treatment of the water at one or more of the treating plants or because the boiler had not been washed. On its evaporation limit, considering the amount of water used, numerous cases of foaming during this period from September 1, 1922, to April 1, 1923, were caused by soap, rod cup grease, lye, washing powder and other foam producing substances put into water cisterns of locomotives during the shopmen's strike and which was charged in some cases to soda ash and lime water treatment.

After overcoming this difficulty no trouble was experienced from foaming except on rare occasions when water is given an over-dosage of chemicals or failure to wash the boiler at the proper time.

During the low water stage of the Missouri River the first part of this year when the total hardness was as high as thirty grains to the gallon, it was necessary to use excessive quantities of chemicals to reduce this hardness to four or five grains.

This made the water so light that foaming ensued on engines engaged in heavy service where fire-box temperatures were high to maintain steam pressure for the service the engine was performing. During such periods anti-foam compound in quantities of one pint to each 4,000 gallons of water is used, which eliminates the foaming difficulties and permits of efficient and economical locomotive operation.

During the first three months of the soda ash and lime water treatment several engine failures occurred on account of burst flues; in each case it was found that the failure was caused from pitting—the chemical qualities of the water having removed the scale formation, allowing the flue to break, and in many cases a total engine failure ensued.

During the shopmen's strike beginning July 1, 1922, we experienced very little boiler or flue leakage on locomotives operating with the above treated water and very good results and improved engine performance was made possible on the second district where locomotives operated that only received approximately 20 per cent treated water.

Flues removed from locomotive boilers operating on the treated water district are not altogether free from scale, as the locomotive was either in service before the advent of feed water treatment or was sometimes run for several trips at a time over other territory where treated water is not available. The number of hot work boilermakers has been reduced 50 per cent in the main terminal since starting the soda ash and lime treatment, which is evidence of reduction in number of engines with leaky flues and fire-boxes and an assurance of a longer life flue.

It is quite noticeable, however, that the interior of boilers are in an improved state of preservation with a very thin coating of soft chalking scale that is easily removed.

The old practice of blowing out large quantities of water at each water station has been discontinued, and instead the blow-off cocks, of which there is one on each side of the boiler, are operated for a few seconds at frequent intervals, thus releasing the accumulated sludge adjacent to blow-off cocks.

The results obtained from the above treatment and methods of handling have fully justified the cost of installation and maintenance.

For a distance of 300 miles where the road traverses a hilly country where agricultural development is very limited adjacent to water stations where water is obtained from streams, there is no difficulty experienced from foaming, and scale formation is found only in limited quantities and no water treatment whatever is used. When we reach the Red River country of Arkansas, Louisiana and Texas we find the water to contain such quantities of hardness that heavy formation of scale and pitting prevails. Anti-foaming compound is being used to avoid scale formation with very satisfactory results. A boiler recently inspected was found to be practically free from scale, but was badly pitted due to action of the water prior to use of anti-scale compound, which had almost completely removed the scale in a few months' treatment.

In this territory it is necessary to use anti-scale compound to preserve the metal of the boilers, changing the amount used to meet water conditions that change only in the wet and dry seasons of the year.

When excessive quantities of anti-scale compound are used, sometimes foaming results, and to avoid foaming each locomotive is furnished a supply of anti-foaming compound for use only in case of foaming.

In a salt water territory where water contains from 45 to 65 grains of salt, trouble is experienced from foaming on an evaporation of 4,000 gallons of water with boiler of approximately 3,200 gallons capacity. The foaming tendency develops on a salt concentration of 100 grains and the locomotive becomes almost inoperative on a concentration of 175 grains. This difficulty is readily overcome by the use of anti-foam compound and the boiler blowed out good every four hours, water changed on four days' performance and washed after each seven days' run.

The water consumption averages 870 gallons per hour, the boiler blow-out releasing about 400 gallons on each 4,400 gallons performance, water changed on 28,000 gallons and the boiler washed on an evaporation performance of 48,000 to 50,000 gallons.

Under this method of handling locomotives are operated successfully. The evaporation between wash-outs could be increased by the greater use of blow-off cocks, but the additional cost due to waste of fuel would more than offset the costs of wash-outs and fuel for firing up.

An ideal method of obtaining the correct concentration in a locomotive boiler is to tap into a wash-out plug near the back end of the fire-box and insert a pipe with suitable valve and fittings, and in this manner secure samples of water when the locomotive is laboring hard, fire box temperatures are high, injectors working and the circulation of water is the highest. In this manner the correct concentration is available and such information should be used in arriving at just how long the locomotive should run between wash-outs.

It has been the past practice to wash boilers on a calendar-day instead of on evaporation performance, which is not satisfactory in pooled engine service, as locomotives often work from twelve to twenty hours per day in times of heavy traffic movements. Then there is the case of engines operating over the same territory—one on fast schedule with light trains and the other with heavy drag tonnage where the evaporation per run or day is 100 per cent greater than the engine handling the lighter load. Hence the importance of wash-outs when the concentration has reached a point that indicates boiler disturbance.

There are numerous compounds on the market for the treatment of locomotive feed water, each of which may be used successfully in certain waters; but there is none that will successfully handle all waters. Therefore the treatment of feed water is an exact science just as much so as the building of a locomotive by men who have learned from experience. There are factors to contend with which can only be successfully handled by men well versed in chemistry, who would be able to anticipate what the after deposits from a combination of waters may be in a locomotive boiler, and then be able to prepare a treatment to suit that condition. Such knowledge can only be gained from long experience with a properly equipped laboratory specializing in the study of locomotive boiler feed waters.

It may also appear that the treatment of water for locomotive boiler use is no different from stationary practice. When you consider that the ratio of heating surface in locomotive practice is approximately 3½ square feet per horsepower, while in stationary practice the heating surface is possibly ten square feet per horsepower, the surface resistance of the water in the boiler must be given full consideration. An extremely high concentration of sodium salts is not permissible in locomotive boilers, due to great and sudden fluctuation in power required to be delivered by the locomotive and the constant rolling motion of the locomotive, all of which tends to induce foaming; therefore a suitable water treatment for locomotive boiler use should not be of sodium salts structure, but of a character that would combine with the solids found in the boiler water (all of which are thrown out of solution during the process of evaporation), and cause the solids to be precipitated in the form of a sludge, in which form it may be effectively blown out of the boiler with a minimum use of the blow-off valve. At the same time the coagulating effect will produce a clearer water, increase the surface tension and improve the quality of steam and thermal efficiency of the boiler. If on the other hand, quantities of soluble matter are added, there will occur a rapid concentration which will require excessive blowing out of the boiler in order to hold the concentration down to a point of possibly less than 125 grains per gallon of water contained in the boiler, in order to prevent foaming.

As previously stated, the item of fuel losses as result of water blown from the boiler is greater than it appears to be when we consider that for each gallon of water blown from the locomotive boiled at 200 pounds pressure, the fuel loss is equal to something over one pound of coal, or, to be exact, 9,704 B.T.U. represent the heat contained in one gallon of water in a locomotive boiler at 200 pounds pressure, and assuming the thermal efficiency of a locomotive boiler to be 6 per cent using coal 14,000 B.T.U. per pound, the amount of coal required to bring one gallon of water under 200 pounds pressure up to a temperature corresponding to that pressure is 1.21 pounds or 2,400 pounds of coal for each 2,000 gallons of water blown away.

There has in the past been a great deal said about proper use of the locomotive blow-off valve, but the point in question here is the difference in the amount of water necessary to blow from a locomotive boiler, to reduce the concentration of soluble salts or to remove soft mud that has been thrown down onto the foundation ring. In the first instance, to reduce concentration 25 per cent, it is necessary to remove from the boiler more than 25 per cent of the water contained therein, as the fresh water going into the boiler, replacing the water blown out, will carry back into the boiler a quantity of sodium salts, starting an immediate reconcentration.

In the second place, by proper manipulation of the blow-off valve, mud can be pumped out from around the boiler leg, with loss of very little water, thereby effecting a fuel saving and avoiding an excessive use of the blow-off valves, abuse to boiler, and the replacing of large quantities of water at times when boiler is at rest, or the forcing of boiler in order to replenish water that has been blown away when being worked possibly to its normal or maximum capacity, as that is usually the time when the necessity of using the blow-off becomes evident.

Since the coming of the superheater it has been possible to apply water treatment that could not be used advantageously before the advent of the superheater. This is an important matter and should be given close consideration for the reason that the superheater is being used in many cases to correct the ill effects of tendencies to foaming, due to the use of water treatments not scientifically prepared to meet the conditions prevalent in the locomotive boiler, which means a drop in the superheated steam temperature and a corresponding drop in draw-bar pull, as well as a decrease in thermal efficiency of the boiler, with a corresponding increase in fuel consumed.

In one locality we found boiler foaming presumably on account of using a certain boiler compound, but upon investigation of the subject it was found that the engines were being run far beyond the limit possible on account of the high concentration. The past practice was to wash the boilers every seven days and the water being of such hardness and tendency to foaming that both anti-scale and anti-foam compounds were used. These engines, however, worked from twelve to twenty hours per day in pooled service instead of eight hours per day on former regular assignment, therefore the evaporation between washout had been increased from 50,000 (where the concentration was great enough to justify wash-outs) to over 110,000 gallons, when excessive foaming developed, making economical and efficient locomotive operation an impossibility.

This difficulty has been overcome by adopting a boiler wash-out board to be handled by the engine dispatcher or enginehouse clerk who marks up the board every trip the engine makes and when it has made the desired number of hours or miles the boiler is washed out. The evaporation in that particular locality is about 7,000 gallons per eight-hour run and the concentration limit is 50,000 gallons; boilers are therefore washed after the seventh trip and foaming eliminated, making possible a far better locomotive performance.

The fact should not be overlooked that there are certain waters which should never be used for boiler feed purposes and which no treatment could render suitable for steam-making purposes.

All the boiler feed water compounds used we might say have been a failure and a success; a failure on account of the improper handling by water service men, roundhouse and engine service employees, who have, in so many instances, failed to carry out the instructions issued—sometimes failing altogether to apply the proper quantity required for a certain quantity of water and in other instances not using the compound or treatment at all, while in another instance there is the fellow who believes if a little treatment is good a greater quantity will give better results.

In one instance we found where an engine in pooled service was ordered for a run, the water tank supplied and proper amount of compound applied, but the engine was not used on that date and was run out the next morning after about one-half of the tank of water had been wasted. The cistern was again replenished and the full amount of compound applied. After leaving the terminal a short heavy grade was encountered and the boiler began to foam. The engineer, not knowing that the water supply had already received an overdose of chemicals at the terminal, applied more compound in an effort to settle the foaming conditions. This resulted in a total engine failure, it being necessary to double the hill and at the next wayside tank the boiler was filled and blown out several times and the tank replenished with clean water. The engine then negotiated the other part of the district successfully, failure being charged to foaming of boiler due to use of anti-foam compound, when it should have been charged as a man failure.

This is only one of many similar failures due to the improper handling, but there are the majority of enginemen who make a success of the use of feed water treatment and who would not favor leaving a terminal without ample supply of compound to successfully treat the water with which they are supplied in certain territories.

We will never realize the possible results of interior boiler feed water treatment until some mechanical means is devised and adopted that will automatically proportion the amount of chemicals introduced into the locomotive boiler with a given quantity of water, thus remove the possibility for failure of enginehouse and other employees to properly handle.

We have no figures available to indicate the actual savings possible, resulting from the proper application of the different chemicals used and the different methods employed in the handling of locomotive feed water treatment, but the results obtained have been satisfactory.

Since compiling the above, two of our committeemen have submitted the following:

"Beg to advise that we now have in operation eleven lime and soda ash water softening plants and are constructing twenty-four additional plants. In addition to this we have twenty soda ash water treating plants in operation and thirty-three constructed which will be in operation by the end of July.

"We have not yet compiled statistics showing the actual economy of treatment, but in a general way are in position to state that results are very gratifying. We are successfully softening with a lime and soda ash softener a well water containing sixty grains of incrustants per gallon, the greater portion of which consists of calcium sulphate. On the district where this water station is located there are other waters which are very heavily treated with lime and soda ash, and we find it advisable to use anti-foam boiler compound.

"It has been our experience that most cases of foaming can be handled by proper use of the blow-off cock. However, under certain conditions, it is more economical to use the proper anti-foam compound.

"After we have had our plants all in operation for a year, it is our intention to make comparative figures which will show actual economy detected by the use of soft water."

Referring to the methods used in treatment of water for locomotive use on the Pere Marquette Railroad, would say that on the Chicago Division, between Grand Rapids and Chicago, also on sub-division between Holland and Pentwater, boiler chemicals are in use, while on the territory between Toledo and Saginaw we are using another compound. These chemicals in each instance are being tested out on their respective territories with a view of determining what process of treatment we wish to adopt as a standard.

By the use of one of these compounds the scale does not all drop off, but most of it is softened up, hanging in a loosened condition; in fact, some of the heavy scale on the bolts and braces, while not broken off, is loosened and will turn on the bolts and braces similar to a bushing, most of which is dislodged, broken up and washed out at the following wash-out period. Great care is necessary in washing the boilers that are heavy with scale before applying this treatment, as large quantities of scale will be dislodged and accumulated, resulting in mud burnt sheets.

Another compound of different elements applied by placing the required amount into a container, which is attached to the intake pipe of the wayside tank. An analysis of the water is taken in order to determine the amount of compound that is necessary to neutralize the water at any particular tank. The chemical acts by attacking and precipitating the scale-forming solids in the water before it reaches the locomotive tank, thereby prohibiting, to a large extent, the formation of scale.

The water used by locomotives on our railroad is, with very few exceptions, taken from freshet streams, and averages from sixteen to forty-four grains per gallon in scale-forming solids. In most of these exceptions, water is taken from Lake Michigan and averages approximately nine grains of scale-forming solids per gallon.

We have practically no trouble with engines foaming or boilers pitting. Our problem is to keep our boiler tubes, bolts and sheets from being insulated with scale. The scale is of the carbon magnesia type, and before using any water treatment it was not uncommon to find the tubes, bolts and sheets insulated with scale three-eighths to one-half inch in thickness. In some instances scale formation exceeded these dimensions.

As I have previously stated, we have had practically no experience due to engine foaming, therefore, we have had no experience in the use of anti-foam compound, and, furthermore, we have had very little experience in the use of soda ash; however, in the few instances where soda ash has been used we would experience some trouble due to engines foaming.

Our instructions are to use the blow-off cocks intermittently, opening for a period of five seconds, then closing and opening again. The use of our blow-off cocks is not as intensive as on most railroads, largely due to the fact that enginemen are given very little trouble due to engines foaming.

We feel that we have derived considerable benefit from the use of the boiler compound; while it has entirely eliminated the formation of scale on our boiler tubes, sheets and bolts, it has greatly reduced the thickness of scale insulation. It is a rare instance to find over one sixteenth to three thirty-seconds of an inch scale on engines running in territories where boiler compound is in use. This reduction in scale formation has resulted in a corresponding reduction in fuel consumption. Where formerly it was necessary to reduce nozzles as scale formation increased, we are now maintaining a standard size nozzle. Engines that were formerly run with 6-inch nozzles are now running with 6¼-inch nozzles. This has not only reduced the fuel consumption of our locomotives, but has increased their efficiency, due to the larger nozzle decreasing the back pressure in the cylinders. We have not only increased the life of our flues from four to six months, but have reduced our number of hot workers at Saginaw and Wyoming roundhouses. We have nine less hot workers employed than formerly; this alone at these two roundhouses has resulted in a saving of approximately $50.00 per day or a total of $18,250.00 per year. At our power plant at Saginaw shops we have a battery of four 250-horsepower Wicks type boilers. It formerly took two men eighteen hours to thoroughly wash and turbine each of these boilers, which were washed once every thirty days. This is now being handled by the same number of men in an eight-hour period, and the wash-out has been extended from thirty to sixty days.

Before using the water treatment on these stationary boilers it cost us approximately $17.64 for each boiler washed or a total of $70.56 each thirty days to wash the four boilers. This has been reduced to approximately $7.84 per boiler or a total of $31.36 for the four boilers. We were formerly washing these boilers twelve times a year at $70.56, resulting in a total cost per year of $846.72. The cost having been reduced to $31.36 and decreasing the wash-out period to six times instead of twelve, has resulted in an annual saving of $658.56. We have not increased the period between wash-outs on our locomotives, the practice being to wash engines every ten days. However, it has been shown that we have considerably decreased the working of flues, which is largely responsible for the extended life of the flues.

The committee that presented this report consisted of Messrs. T. H. Clapham, Chairman, G. M. Basford, C. F. Willoughly, J. H. Alter, and J. H. Cooper.

Building a Locomotive an Hour

It is reported that the Baldwin Locomotive Works recently turned out an engine per hour for thirty-one hours.

Each one of these engines is capable of hauling at least seventy-five freight cars holding an average of twenty tons of goods, or 1,500 tons. Thus in thirty-one hours, the railroads of the United States have had 46,500 tons increased capacity added to their facilities.

It would not take long to catch up with the transportation overload if the roads could buy locomotives as fast as the builders can produce them.

Manual of Standard and Recommended Practice

The revision of the Standard and Recommended Practice of the Mechanical Division, American Railway Association, as the result of 1922 Letter Ballot action has been prepared for the Manual of Standard and Recommended Practice in loose-leaf form for insertion in the Manual of 1922. This revision includes, in addition to the changes and additions to the Standard and Recommended Practice, revision of title page, general index and indices of the section affected.

Complete set of revised pages to bring the Manual up to date will be supplied on requisition at the following prices: To members of the Association, $1.75; to other than members of the Association, $3.50.

This revision, including indices, consists of 188 pages. To those who have not already secured copies of this Manual same will be supplied on requisition at the following prices, revised to date, on application to the Secretary, V. R. Hawthorne, 431 So. Dearborn St., Chicago, Ill.

To members of the Association:	
Manual complete, including binder, per copy	$6.00
Separate sections complete, self covered in paper, per copy	.50
Separate sheets, each	.05
To other than members of the Association:	
Manual complete, including binder, per copy	$12.00
Separate sections complete, self covered in paper, per copy	1.00
Separate sheets, each	.10

Locomotive Terminals: Mechanical Department Requirements*

By L. K. SILLCOX, Gen. Supt. Motive Power, C. M. & St. P. Ry.

From the statistics compiled for all railroads in the United States, it has been determined that in every 24 hours the average serviceable freight locomotive is used a little less than eight hours in actual road service. This excludes and therefore gives no consideration to serviceable engines stored, to engines held at round-houses 24 houses or more for repairs or tests, nor to engines in back shops undergoing classified repairs. The situation is further intensified by the fact that the average annual locomotive service days range from 300 to 330 days out of the 365 days of the year, or approximately 80 per cent. Therefore, of the total complement of locomotives owned, approximately 80 per cent are serviceable throughout the year, and of the 80 per cent serviceable, only 33 1-3 per cent of the actual hours in service are utilized so that the net amount of service obtained is but approximately 28 per cent.

Therefore, since the engine is in service an average of only 8 hours of the 24 hours each day, the inference is that the remaining 16 hours are consumed at the terminals in conditioning the engine for another trip and awaiting call. It would appear that these 16 hours represent a tremendous waste of time, and that earnest endeavor should be made to recover it for revenue service. However, consideration should be given to the fact that a certain amount of this time is absolutely necessary for preparing the engine for service, so that it is not possible to recover all of the 16 hours.

A chart has been prepared representing the distribution of the 24 hours of the average serviceable freight locomotive day. Following the 8 hours used in actual service are the 16 hours consumed in terminal detentions.

From reports of engine-house performance, it has been determined that the average serviceable locomotive is turned approximately 1.4 times in every 24 hours, from which information it can be assumed that the average time required to turn an engine is about 11½ hours. For this reason the 16 hours of terminal detentions have been divided on the chart and 11½ hours indicated as representing one complete engine turning, with the remaining 4½ hours considered as a portion of the next turning. An analysis of the various operations constituting an engine turning in the usual sequence of their occurrence indicates a grouping into four main divisions. These divisions with the average approximate time element of each, are as follows:

	Hours
1st Div.—Movement of the engine from the train to the engine terminal	¾
2nd Div.—Roundhouse care and ordinary repairs	8
3rd Div.—Extraordinary repairs and awaiting call	2
4th Div.—Movement from outbound track to train	¾

The first division represents the time consumed in releasing the engine from road service and delivering it to the engine terminal; or in other words, what is usually termed outside hostling. This movement is made by the engine crews or by the outside hostler, as the practice may be. The time element of this division is the function of the terminal layout, and whether it takes more or less than the ¾-hour period indicated will depend upon the relative location of the engine terminal with respect to the train yard and the track arrangement leading into the engine terminal.

The several operations constituting the second division, when taken in their usual sequence, average approximately as follows:

	Hours
A—Removing supplies, outside inspection, and knocking fires	1
B—Movement from cinder pit into roundhouse stall	¼
C—Inspecting, repairing, cooling down and washing boilers and tanks	2½
D—Wiping, completing repairs and filling boilers	2½
E—Building fires and steaming up	1
F—Movement from roundhouse to outbound track, taking coal, water, sand and supplies enroute	¾
Total	8

It must be understood that this grouping of operations with the time elements selected are more or less hypothetical. However, the selections were prompted by observations and experience, and, therefore, represent very closely typical averages. It is not to be expected, for instance, that a boiler could be washed in 2½ hours, but it must be remembered that the boiler is not washed every trip and that this merely represents an average of all operations for all locomotives.

The third division is necessary to provide a period for overlapping to take care of extra repairs and to compensate for slow operations at points where sufficient facilities are not available for the prompt turning of power. It also allows for the margin of time between when the engine is ready and when actually put into service. This division, therefore, bears a joint responsibility of the mechanical and transportation departments, as these detentions are the function of the speed of terminal performance and the utilization of power.

The fourth division represents approximately the average time consumed in handling the engine by engine crew or outside hostler from the engine terminal to the train yard after the engine has received coal, water, sand and supplies. As with the first division, the time element of this is also dependent upon the location of the terminal and the track layout leading from the terminal to the yard.

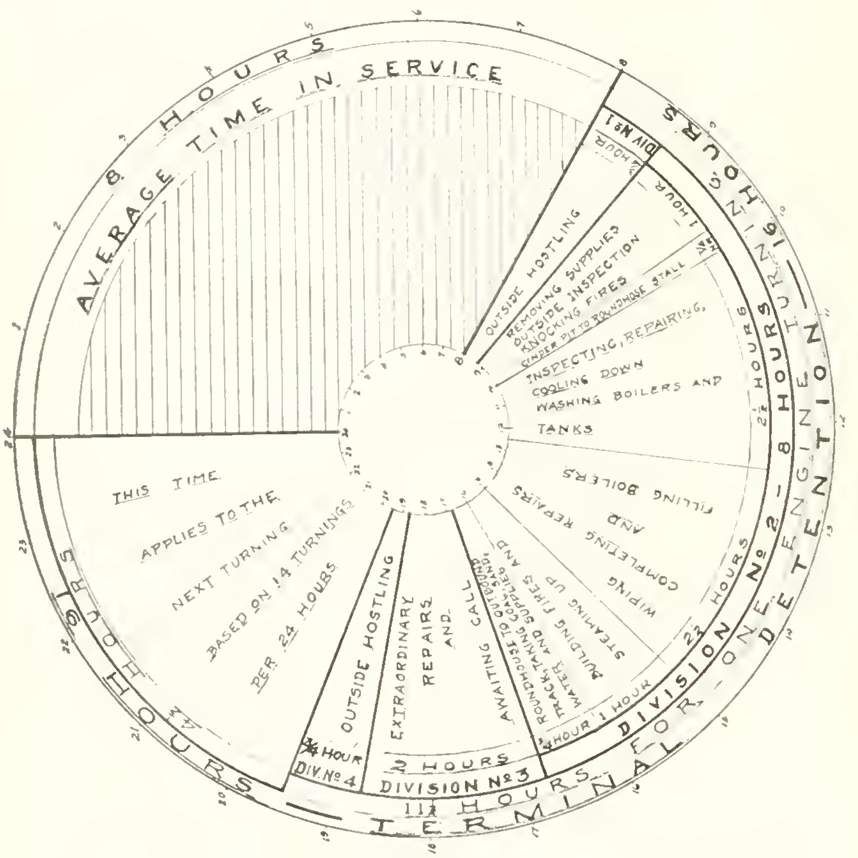
Therefore a medium of measure is established for comparison. However, it cannot be applied literally, for it represents the collective results rather than that of the specific terminal and comparisons, therefore, should be made by grouping terminals either by divisions or districts. This becomes apparent when considering the supplementary roundhouses where no machine shop facilities are available as against the major terminal which is well equipped for making heavy repairs. The former merely constitutes a turn around point where the engine is turned and provisioned, while at the latter the attention received will be more extensive and will include repairs, so that it would not be fair to compare the one against the other merely on the time element basis. The combined result of the two, however, could be compared equitably with the results as indicated on the chart.

* A paper presented before the Western Society of Engineers.

There are four fundamental factors relating to the proportion of time in service and out of service:

1. Mileage and time between terminals.
2. Demand for power.
3. Terminal lay-out and the location with relation to the train yard.
4. Facilities for conditioning engines for service.

From observations made of the performance on various railroads, especially when making a study of engine-house expense, it appears that there are various basic elements which affect such performance, among which can be considered the average miles between engine terminals. A study of eight carriers reveals that the average distance between terminals ranges from 57 to 114 miles. They have a very wide range when considering the cost of turning freight engines per freight train mile and likewise the cost of turning passenger engines per passenger train mile, and it is found that each cost varies inversely with the miles between the terminals. In other words, the greater the distance between terminals, the less is the cost of turning engines per train mile. Too much stress cannot be placed upon the location and spacing of engine terminals. In the spacing of terminals, however, consideration should be given to mileage and time as affecting the scheduling of train crews, as otherwise any gain made in the saving of engine-house expense may be offset by overtime incurred by the train crews.



Distribution of the 24 Hours of the Average Serviceable Locomotive Day

These studies also indicate that there is a great variation in frequency of turning the engines and depends upon the distribution of the power according to the demand, the amount of power owned in proportion to the volume of traffic, and most of all, the frequency of terminals. When there is a large number of power units, but a great frequency of terminals, short runs will prevail, whereas if the runs are longer, the number of service hours per day will increase, the dead time at terminals will be reduced and the gross ton miles will increase, with a consequent increase of earning power per locomotive. The spacing of terminals has an effect on the serviceable hours per day, but this should not imply that this advocates unnecessarily long runs or the skipping of terminals, but rather providing a rearrangement that will give a more uniform distribution of terminals so as to reduce the amount of terminal handling to a minimum consistent with the volume of traffic.

The question of margin of power is also very vital and must be considered before any step is taken at any one terminal to improve it out of proportion to the neighboring terminals. As an illustration, there may be an engine terminal where there are from 20 to 22 engines in the house at all times, with an average of only eight departures and eight arrivals in the 24-hour period. In such a case, the dead time proportion of the 24 hours would be very large and would require a relatively small force to operate the terminal and possibly permit the use of two instead of three shifts. On the other hand, there may be an engine terminal with only 12 engines in the house at all times and with an average of 10 arrivals and 10 departures every 24 hours. Here there would be a more intensive operation requiring a relatively large force, possibly three shifts, also requiring facilities which would permit the turning of power in less than eight hours so as to be in a position to overcome any emergency.

The relative location of the terminal with respect to the yard and depot is a factor effecting Divisions 1 and 4 of the chart. If the terminal is close, so that the engine may be uncoupled from the train and delivered directly to the engine terminal, there will be only a few minutes involved but if a long distance away or the movement involves complicated switching, the time loss becomes a large item.

The layout of the tracks both leading to the terminal and within the terminal greatly influences the time element. The layout should be flexible and allow for free and unencumbered movements in proper sequence. There should be no interference between inbound and outbound movements. Coal and water facilities should be provided in such a way as to serve both inbound and outbound tracks, with greater capacity for the outbound engines. Outside facilities should be provided, with due consideration to climatic conditions. Sufficient well-disposed artificial light should be furnished. Cinder pits for ample and reliable service are necessary. Where the volume of traffic is large, outside covered inspection and repair pits are of great value in speeding up the movement of engines through the terminal.

It would appear, therefore, that there are two avenues open for the study of means to improve the situation with the view to reducing the amount of time involved in terminal detentions, with the consequent increase of time in road service: one is to establish fewer and more properly spaced terminals; and the other to provide adequate facilities for turning and repairing locomotives. Referring again to the chart, by the proper spacing of terminals, with a consequent reduction in frequency of terminals and lengthening of runs, the tendency would be to produce longer hours in service. If terminal facilities are available, and the proper demand for power prevails, there will be a reduction in the time required at the terminal.

The ideal performance would be to permit an engine to be double crewed, thus running from 14 to 16 hours and leaving 8 to 10 hours in the roundhouse. It would be necessary under such conditions to have the proper facilities for a quick turning so as to allow the necessary margin for awaiting call and for emergency repairs. Therefore, the important feature in increasing the serviceability of the locomotive is the ability of the terminal to turn the engine in less than eight hours, and preferably accomplish this in about five hours. When considering the distribution of time as shown on the chart, it would seem that with but slight improvement in the facilities for turning and repairing power we could attain the performance of double crewing engines where now we are single crewing them.

Regardless of the adequacy of any engine terminal, it cannot be expected to perform to its full capacity without proper management. In order to have a well managed plant, it is necessary for the men in charge to have a well-defined knowledge of each and every operation, considering time, capacity and cost. The following chart shows relative differences in the cost of the various operations constituting an engine turning exclusive of repairs. With such information, the man in charge should be able to regulate his output and expense in such a way as to operate his terminal economically and efficiently.

This chart shows the per cent that each group of operations bears to the total labor cost of engine-house expense, and is compiled from information collected by one carrier. The various elements constituting the several groups selected are as follows:

Supervision—Pro rata portion of salaries and expenses of foreman and clerks.

Engine Handling—Out side and inside hostling, watching outside of house, calling crews, drying sand and provisioning.

Cleaning Fires and Wiping—Knocking or cleaning fires, ash pits, etc., and wiping engines and tenders.

Washing boilers, tanks and water changes.

Cleaning flues—and inside of front ends, fire boxes, brick arches, draining and cleaning air reservoirs and air equipment.

Inspecting front ends and ash pans.

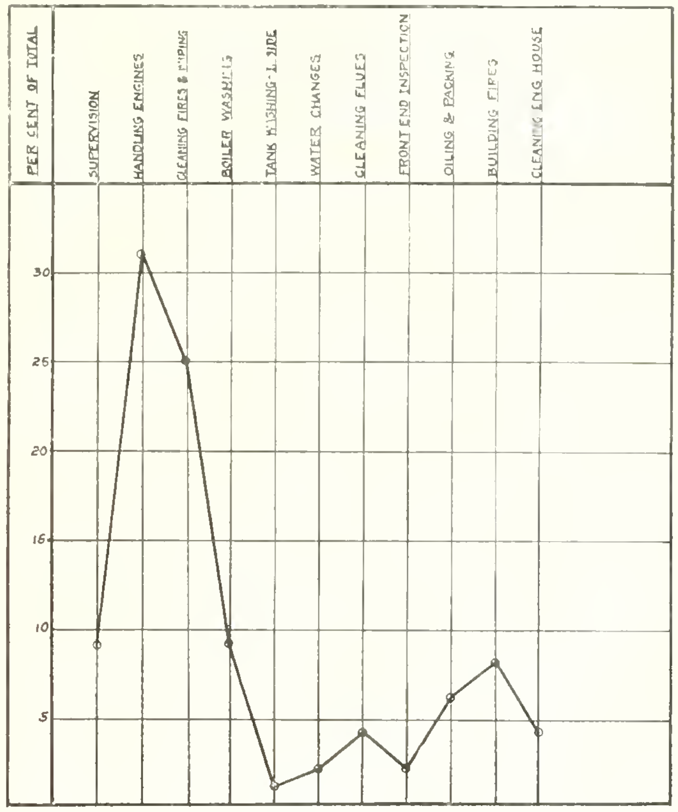
Oiling and packing—labor only.

Building fires and watching in house.

Engine-house cleaning.

Note that the cost of handling engines represents 31 per cent of the total cost of turning (exclusive of repairs). This element is not within the full control of the men in charge. This is partially represented by divisions 1 and 4 of the chart. It rather reflects the relative location of the terminal lay-out with respect to the train yard. The cost of the cleaning fires and wiping engines, which in this case is about 25 per cent, reflects the efficiency of the cinder pit operation, which is one of the operations that should be so arranged as to have proper facilities to keep the time and cost down to a minimum. The cost of boiler washing represents 9 per cent of the total, due to the fact that boilers are washed on an average of once every four or five trips. This expense can be materially reduced with hot water boiler washing equipment, and, in addition, such equipment will reduce the time required for this operation. The other elements shown on the chart are of a minor nature but need watching in order to keep them down to a minimum.

To the mechanical man, the engine terminal is a facility, or, in other words, it is merely a tool with which to perform a specific operation in detail. It is a double-edged tool, as there are two functions to perform. The first of which is the ordinary handling and care of the individual locomotive in the roundhouse, and the other is repairs, both lighter classified and running. In the well-ordered performance of locomotives, it is necessary to divide the maintenance into running and classified repairs. The running repairs must of necessity be made in the roundhouses. It has been the usual practice to do the classified repairs in the back shops, but there is an increasing tendency to do the lighter classified repairs as well as the running repairs in the roundhouses in order to get a more intensive use of the power. It is the custom among some carriers to assign a certain mileage for a locomotive to perform between classified repairs, and in order to operate locomotives at a minimum cost per mile, for all classes of repairs, it is necessary to obtain a consistent balance



Relative Labor Cost of Various Operations in Engine House Expense

between the cost of classified repairs and repairs made in the roundhouses. The manner in which roundhouses are equipped with repair facilities determines the balance.

It is the practice on many lines to send locomotives to the back shop only when in need of heavy boiler repairs, taking care of all other work as due in the roundhouses. It is a function of the roundhouse, therefore, to obtain from the locomotive a specified performance in mileage and time, and to see that every engine leaves the terminal in proper condition to insure a successful trip.

The roundhouses usually perform maintenance work on locomotives to the extent of approximately 40 per cent to 50 per cent of the total cost of repairs and should therefore be equipped with this in mind. Any ratio ranging from 60 per cent for classified repairs to 40 per cent for running repairs on the one hand or from 50 per cent for classified repairs to 50 per cent for running repairs on the other hand would seem practical. The ratio between the cost of repairs done in roundhouse and back shop depends largely upon the policy pursued with respect to the extent of the work expected from the roundhouses.

As was mentioned at the beginning of this paper, the average locomotive produces annually from 300 to 330 serviceable days out of the 365 days of the year. The opportunity for producing higher efficiency in serviceable days per year obtains from the ability to keep the locomotive within the jurisdiction of the local man and this can best be done by providing him a well selected supply of standard repair parts and materials, and with ample facilities with which to make prompt replacements and repairs when due, thus eliminating delays occasioned in waiting for parts and materials from the main shops, or in transporting the engine itself to the main shops for repairs.

It is a more difficult burden to maintain the larger units of power that now predominate than it was to care for the smaller engines that were in use in the past. The modern engine is heavier and more complicated, and requires more consistent and frequent mechanical attention. The various parts of the locomotive are larger and heavier and cannot be repaired quickly, if there are not adequate facilities at hand with which to handle them. Generally speaking, the increase in the capacity and extent of facilities in roundhouses has not kept pace with the increase in number and size of power units, and until this is brought to a proper balance, it cannot be expected that the full serviceability of the modern power will be attained. A modern locomotive represents a large capital investment and idle hours are of a relatively greater loss than in previous years.

In order to illustrate the general situation on a large railroad system, it is necessary to know just how the various divisions range as to the volume and density of traffic. This forms the knowledge necessary to understand the proper assignment of power to divisions after considering track gradients and curvature, and other operating features. A high performance in car miles per day is not obtained by train speed, but by the promptness with which trains are broken up, assembled, and moved through terminals. A terminal should be prepared to handle without delay any reassignment of power for seasonal loading or other reasons. Improved engine facilities should be made with consideration of the general situation, strengthening the weaker points first and thereby building up to a higher general efficiency.

An ideal is unattainable. It is something for which we strive, but which we never quite accomplish. There is no such thing as an ideal engine terminal or an ideal terminal operation. From the very poorest to the very best they are a compromise. There are so many circumscribed elements affecting each point that regardless as to whether it builds up by gradual expansion or is constructed new, the final lay-out will always reveal some undesirable features. Financial stringency will retard development and restrict new construction. Precedent hampers relocation of existing facilities. A good labor market often overbalances other advantages and designates a location that is geographically or otherwise improper. So we must compromise and use to the best advantage what we have and that which we can obtain.

We are confronted with the problem of not only creating modern terminals in new locations but of overcoming a situation that has developed in a rather evolutionary way with the growth of the railway property. Terminals constructed in new locations can easily be equipped with all the proper and modern facilities required for economical and prompt handling of power, but it is more difficult to rearrange existing facilities than to construct new ones and it is this feature of the work which will require our attention for many years to come.

To illustrate the importance of improving engine terminal facilities and relocating them to reduce the time element per engine turned and the frequency of turnings: the average cost of turning power is now approximately $6.00 to $8.00 per engine turning and the average number of turns per day is 1.4 times per serviceable locomotive day. A revision of facilities that by reducing the time element of turning would produce a reduction of 50c per engine turned and reduce the frequency of turning 0.1 turning per day (say from 1.4 to 1.3), will accomplish an annual economy on a complement of 2,000 locomotives to the extent of approximately $650,000, an amount that would pay interest at 5 per cent on $13,-000,000. Such an appropriation, properly distributed over the system, would provide for a great many time saving features which if utilized advantageously, would produce large returns on investment and at the same time recover many serviceable locomotive hours to revenue service.

What the Mechanical Department expects from the locomotive terminal is to derive from it a medium by which locomotives may be cared for and maintained properly, promptly and cheaply, and from which locomotives may be consistently delivered to the Transportation Department with the result that the serviceable hours per locomotive per day and the serviceable days per locomotive per year may be increased to a maximum.

Material and Supplies for General Operations Cost $1,668,000,000 Last Year

A study undertaken by the Bureau of Railway Economics, and its findings, just made public, show the extent to which the railroads are among the largest purchasers of raw materials in the country's basic industries.

They buy annually 27.8 per cent of the bituminous coal output and about 6 per cent of the anthracite production. Directly they consume between 12 and 15 per cent of the annual iron and steel output and indirectly about 30 per cent through their orders for all kinds of equipment to equipment manufacturing concerns. In the lumber industry they purchase directly 17.5 per cent of the total cut, and indirectly through equipment orders about 25 per cent of the total output.

In the copper industry the railroads consume annually about 10 per cent of the copper and brass produced. In addition they also buy large amounts of tin, lead and zinc, considerable cotton in the form of cotton waste. Figures indicating their use of cement are not complete, but a few years ago they were using more than 5 per cent of the output and at the present time are using a larger proportion.

The report of the Bureau shows that in 1922 the Class I railroads used materials and supplies costing $1,668,000,-000. This amount and the percentages enumerated above do not include the capital expenditures of the railroads, with the exception of equipment, such as in new construction, the improvement of lines and tracks, new buildings, new shops and other structures. They include only the amounts expended in process of current operations. The purchases of the railroads for capital account, however, sometimes amount to a sum probably almost as great as that from current operations. In 1922, for example, the railroads spent more than $400,000,000.

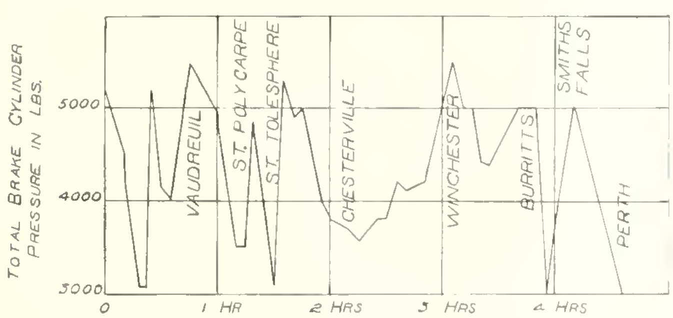
Brakeshoe Temperatures in Service

Considerable attention has been directed during the past year or more to the temperatures developed in car wheels by the brakeshoes, while but little attention has been paid to that of the brakeshoes themselves, though it is well known that the coefficient of friction rises and falls inversely with the temperature.

Some time ago a determination of brakeshoe temperatures was made on a local passenger train run of about

Brakeshoe Temperatures Montreal to Perth

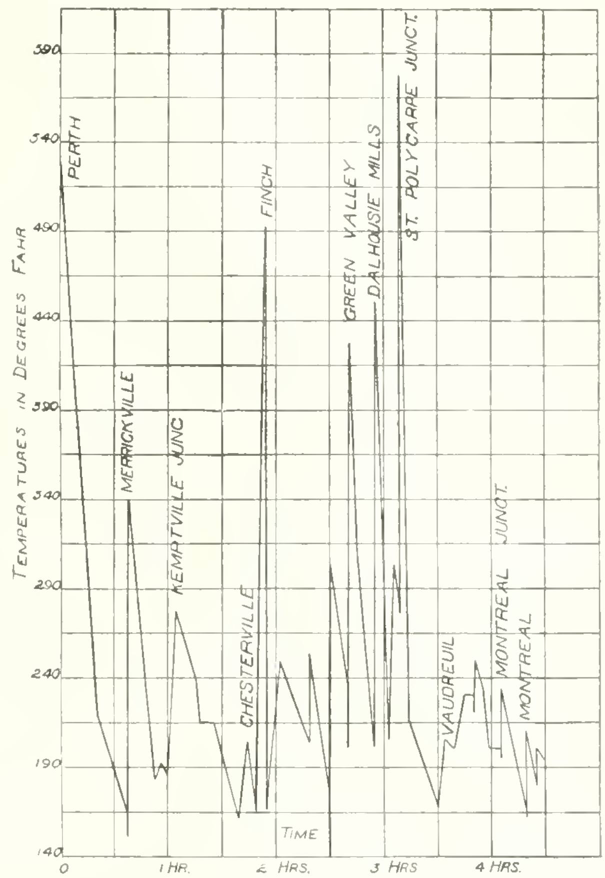
140 miles on the Canadian Pacific Ry. between Montreal and Perth. The grade is an undulating one, with a maximum of 0.88 per cent. The temperatures were taken by a thermo electric couple and pyrometer. It was observed that immediately on the application of the brakes the temperature of the brakeshoe fell until the heat generated



Brake Cylinder Pressure Montreal to Perth

balanced the difference in temperature between the brakeshoe and the wheel, after which the temperature increased. The highest temperature on the run from Montreal to Perth was 500° Fahr. This occurred at St. Telesphore, Winchester and Burritts. On the return trip the highest temperature reached was 572° Fahr. which was at St. Telesphore.

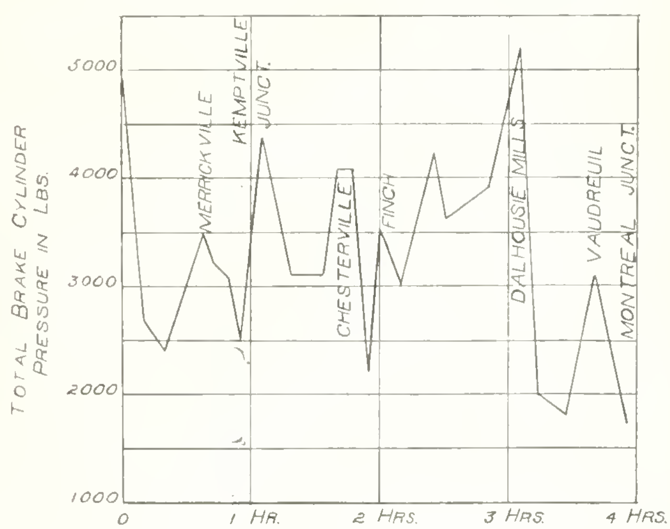
The diagram also gives the total brake cylinder pressure existing on the run. A comparison of these pressures with the line of brakeshoe temperatures shows that temperature often continues to rise after the brake cylinder pressure has been partially relieved.



Brakeshoe Temperatures Perth to Montreal

Naturally the highest temperature occurs after and synchronously with the highest brake cylinder pressure.

According to these diagrams the brakeshoe temperature was continuously above 150° after the first application.



Brake Cylinder Pressure Perth to Montreal

If this is taken as an average condition of brakeshoe temperatures on local passenger trains making frequent stops, it is evident that there must be a decided drop in the coefficient of friction, below the figures ordinarily used, for a large portion of the time.

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The Traveling Engineers' Association

Thirty-one years ago this association came into existence with 14 members, who met in the offices of RAILWAY AND LOCOMOTIVE ENGINEERING, New York City. The first annual meeting was held in 1893, at which there were present and enrolled 53 members. Some few looked with slight misgivings as to the necessity for and probable future growth and usefulness of this new railway association. The founders, however, had a clear vision of what the future would bring forth and the results more than justify their anticipation.

At the Chicago meeting, held in the Sherman House, there were registered 448 members present and a total attendance, including the railway supply men and ladies, of 1,370, an increase of which the society may well be proud.

The railway supply interests were well represented, the displays all being interesting and instructive, while many possessed much educational value, and the arrangement was such as to render them of most easy and convenient access while not in any way making arbitrary demands on the time of those who observed the meeting hours of the sessions.

It is worthy of note that the president's range of vision easily carried him, and beckoned the members to points of vantage far beyond the mere performance of their conventional or set duties, to that more important position most all of them occupy in the operation of our railways. The review of what had been accomplished by our railways served as a splendid tribute to the traveling engineer and doubtless served to inspire them to greater accomplishments on similar lines.

One very important feature worthy of note, is the high character and great importance of the papers prepared by the members, some of them might properly be classed as heavy material for the Mechanical Division of the American Railway Association.

Actual Running Time of Locomotive on Line Hauling Trains

Elsewhere in this issue will be found a most interesting and valuable paper by L. K. Sillcox, General Superintendent of Motive Power, C. M. & St. P. Railway, on Locomotive Terminals-Mechanical Department Requirements, in which the sub-division of time credited to the various operations essential to locomotive operation is clearly brought out, both in figures and by graphic chart.

The possible savings pointed out in the author's summing-up, from a revision of facilities, are not only conservative but should be heeded by all railway executives who have to do with economy of operation.

There is one point in Mr. Sillcox's analysis that may be susceptible to different interpretation, and that is with respect to accredited time in service of 8 hours in each 24. It is assumed this is the average period of time elapsed between the delivery of locomotives to the transportation department for service and their return to the mechanical department, and if this assumption is correct then the delays on line or road, or awaiting to depart from main terminal, are included in the 8 hours of service, and by elimination of these delays or this idle time, the actual running time, producing transportation, would result.

Just what this actual time in hauling a train is, the writer is not prepared to say, but from studies made by students of the subject it would seem to be much below 8 hours.

In a paper before the Western Railway Club some years ago an officer of the C. R. I. & P. Railway gave the distribution of time of assigned freight locomotives, carefully checked as follows:

	Time	Per cent
Round House	6:49	28.40
Running Repairs	2:41	11.18
Classified Repairs	3:27	14.38
Terminal Detention	4:02	16.80
Actual Running Time	4:16	17.78
Delays on Line	2:45	11.46
Total	24 Hours	100%

While this shows the locomotive actually producing transportation only 4 hrs. and 16 min., or 17.78% of its time, it is not set up as a standard for other roads or an average of all roads, as density of traffic, single or double track, yard and siding facilities, etc., all affect or govern this feature. The study is interesting, however, and is offered for its value on the particular feature mentioned.

At the annual convention of the American Railway Master Mechanics' Association in 1905, a report was submitted on this subject by 21 roads, including a wide variety of locomotives and service. The time engines were in the hands of transportation department varied from 21.75 per cent to as high as 89.9 per cent with an average of above 47 per cent, while the time at terminals ready for service was from 2 per cent to 57 per cent, with an average of 31 per cent, making a total of time either in hands of transportation department or awaiting their call of 78 per cent.

A close check of the freight engine for one month made by this same committee showed 77.4 per cent of time in hands of transportation department, and 22.6 in hands of mechanical department.

In the more recent studies on this subject we find in

"Efficient Railway Operation," by Mr. Henry S. Haines, 1919, that the average time of locomotives employed in hauling trains or producing transportation is from 3.97 to 4.07 hours per day, or about 17 per cent, while 83 per cent is divided between repairs, housing and cleaning, awaiting assignment to service and detention on line.

In view of the foregoing, it is suggested that the very valuable paper by Mr. Sillcox might be amplified with particular reference to the item of idle time of locomotives, which represents an investment of say two and one-half billion dollars ($2,500,000,000) and on which the carriers expended last year the following amounts:

Repairs	$448,491,257
Fuel and Water	550,472,953
Engine House and Supplies	141,078,772
Lubricants	9,087,957
Total	$1,149,130,989

That there is room for much economy in their use, there can be no question.

Test Code for Locomotives

The committee of the American Society of Mechanical Engineers of which Prof. J. M. Snodgrass is chairman which has been engaged in the development of a code for the testing of locomotives, has formulated its report, and this, though still subject to revision, has been published.

The introduction divides the tests into the two natural classes, of those made in the laboratory and those made on the road, and places the testing of the auxiliary apparatus on the locomotive in a different category.

"The object of a laboratory test as covered by this code is the determination of the coal and steam consumption per unit consumption of power when the locomotive is operated under fixed conditions."

In entering into the details of the work the code gives twenty measurements that are to be taken in a test. These include all of the locomotive dimensions that have any influence on the work, and all of the conditions affecting the action of the fuel and the steam. It sites sixteen pieces of apparatus of different types and intended for different purposes that should be used. These include the scales for different purposes and such gauges and indicators as may be required.

It gives elaborate instructions as to the preparation of the locomotive for a test. These include the determination of all dimensions; the elimination of leakage or the determination of its exact amount; a general survey of physical condition with particular attention to the amount of wear and the variation from usual conditions; the installation and cultivation of the testing apparatus; the selection, examination and preparation of the fuel, including the chemical analysis and calorific determination of the same.

It sets forth, that, in general, the predetermined operating conditions should be kept uniform throughout the tests, and that the boiler should be free and kept free of scale.

When the locomotive is started it should be run for a sufficient length of time to build a level fire, and should then be operated for at least ten minutes under predetermined operating conditions before the test is begun, the duration of which will depend upon the character of the fuel used, the rate of combustion and the working limitations of the moving parts. The test should preferably be continued until at least 25 lbs. equivalent evaporation of water per square foot of heating surface has been obtained.

Coal and water observations in particular should be taken in such a manner as to facilitate subdivision of the work and in general observations should be taken every ten minutes when it is essential that they should be taken simultaneously.

Then follows an elaborate set of instructions and formulae for the calculation of the results. These cover speed, temperature of the feedwater, humidity of the air, barometric pressure, smoke, quality of the steam, evaporation, water used and lost, allowances for changes of level, heat transfer, steam used, efficiency of the boiler, coal used, amount per horsepower, drawbar horsepower developed, locomotive efficiency, machine efficiency and a number of others.

The data to be included in the report comprise ninety-three physical dimensions and ratios between the parts of the locomotive. The derived data include a complete resumé of the boiler and engine performances with every contributory item in connection therewith.

The object of a road test is the determination of the coal and steam consumption per unit of power, and is, confessedly less accurate than laboratory tests. The precise measurement of coal and water is much more difficult on the road, as well as the determination of some of the other data. Under the usual conditions of road service there are bound to be wide fluctuation in speed, drawbar pull, and rate of firing, all fundamental factors in performance: and even under the most rigid control much of this variation will inevitably remain and exercise an important influence on the results. In a locomotive, cut-off and speed, for example, vitally affect the steam consumption, which varies widely with both; and boiler performance likewise varies greatly with the rate at which the boiler is driven. In short, in a road test we are dealing with a power plant operating under speeds and loads which frequently vary from zero to more than 100 per cent above the average.

If the purpose of the test, therefore, is such as to make necessary an accurate determination of the water rate or rate of evaporation, road tests will not give reliable results and the locomotive must be tested in a laboratory. There are other purposes for which road tests are inherently unsuited. Whatever their purpose, road tests are difficult to make, and unless they are thoroughly prepared for and conducted with great skill and care their results are likely to be misleading and frequently worse than useless.

Owing to the difficulties ordinarily encountered in locomotive road testing it will in general be found inadvisable to make observations concerning certain of the items mentioned unless conditions therefor are especially favorable and extreme care in connection with such observations can be exercised.

For a road test it is assumed that a dynamometer car is available, and the code enumerates fourteen other pieces of apparatus that should be used.

The preparation of the locomotive should be practically the same as for the laboratory tests, and detailed instructions are given under this heading. Then there are further instructions as to operating conditions and what should be done upon the run. Starting, stopping and the maintenance of the fire and water levels receives especial attention. And the caution is issued that every effort should be made that errors arising from inability to accurately measure the coal and water may not constitute an unduly large percentage of the total consumed.

The data to be placed in the report cover such items as the length of the run, time, drawbar pull and other items amounting to one hundred and sixteen in number, including a record of direct observation and derived or calculated results.

The code is so complete and comprehensive that it hardly seems possible to add anything to it, as it includes all details that can have any bearing on the result of a test. So that it would seem as though the next thing in order would be to adopt it as it stands and discharge the committee with thanks of the whole engineering and railroad fraternity.

Scientific Water Treatment for Locomotive Boilers

By W. E. SYMONS

Elsewhere in this issue is published the report to the Traveling Engineers' Association on Water Treatment, in which the subject is reviewed at considerable length and many points of interest are developed.

In the earlier history of our railways, little attention was given to the subject of water except from a quantity standpoint, and while in some instances certain waters were referred to as causing boilers to foam and others produced much scale, yet it may be said a large proportion of railway men viewed all waters pretty much alike. In fact, the attitude of some was pretty much the same as that of the typical "Kentucky Colonel" on the quality of whiskey, who is reputed to have declared that: "There was no such thing as bad whiskey." "Of course," qualified the Colonel, "some whiskey may be better than others, but as for bad whiskey, there is no such thing."

For many years past, however, all railway men who have to do with the operation of locomotive boilers fully recognized that there is not only a wide range of difference in waters, but that special treatment is essential to the best results in use, and that no one compound or preparation of predetermined elements and proportions can be considered desirable for general use, and this for the simple, common sense, obvious reason that what might prove beneficial in one case, might prove highly detrimental in another, hence the absolute necessity of scientific treatment.

As a general proposition, locomotives should as far as possible, be furnished fuel and water suitable for use, as the engine is bought to haul trains, and not to be used as a portable laboratory, while the engine crew are employed to move trains, and not to act as laboratory attendants in the analysis or treatment of waters for locomotive boilers.

As against the above, however, it must be borne in mind that few railways are equipped with a system of water treating plants, and even most of those so favored, find that under certain conditions, the right kind of boiler compound when properly used is very helpful.

The railways that have no stationary water treating facilities in particular, have reason to realize the great benefits derived from the use of a compound scientifically prepared by chemical engineers who specialize in this line, and who only after a thorough analysis of samples of the waters in question, offer a compound suitable for the case in question.

Many of those who have derived little or no benefit from the use of compounds, will probably find on a careful review of all the facts that they have indulged more or less in the use of highly advertised "Cure Alls" that cannot possibly be suitable for all the varying condition due to the entirely different characteristics of the waters to be treated.

The question of fuel economy is also involved, for with some compounds, frequent use of the blow-off cock is necessary to settle the water in the boiler and in this manner millions of heat units, which means fuel, is blown out and lost, thus materially reducing the ton miles per pound of fuel and greatly increasing the cost per ton or car mile for fuel.

When sick or your health is impaired, you consult a specialist who makes a scientific analysis of your case and prescribes a form of treatment calculated to bring relief from your particular ailment. The treatment of waters used in locomotive boilers should be on the same basis.

Senator—Magnus Johnson

The much advertised, and sometimes misrepresented, newly elected United States Senator from Minnesota, Magnus Johnson, made his initial bow to a New York City audience at Carnegie Hall, September 29.

Thirty-two years ago Mr. Johnson landed in New York City on a Guion Liner, a poor emigrant boy from Sweden, seeking home and fortune in the new world, and after 32 years of hardship and sacrifice in the great northwest, he returns to the place where he first set foot on the land of liberty and opportunity, occupying the highest office possible for the American people to confer upon him. Certainly this is an achievement of which any man may well be proud and we not only congratulate Senator Johnson on his success in this country but wish him well in his new field of activity.

Railway and Locomotive Engineering is in no sense a political organ, and will not engage in political controversy, but as it stands committed to the interest of railways and railway men, it would fail in its full measure of duty, should it, through acts of omission, neglect to render aid in matters of vital interest to the railways and we therefore feel it our duty to comment on some of the things Senator Johnson said, and some of the things he *did not say*, but which we will say for him.

We believe the Senator to be honest and sincere, and his desire to aid the farmers is a most laudable one. Having followed the occupation of farming and lived among farmers for the most part of 32 years it goes without saying that he is an expert in that line of human activity, and as a result of association has the viewpoint of others, the combination of which qualifies him to speak as one of authority on farming subjects.

Four years in the lower, and four years in the upper house of legislature in Minnesota also broadened the Senator's scope of knowledge of affairs beyond the confines of his own county and district, and is a fine endorsement of his standing in the community in which he resides.

That the farmers of Minnesota and elsewhere have been exploited by middle or commission men, as charged by the Senator, is not only true but is as great, if not a greater evil in the cities than in the country, and as it effects the economic life of railway men as well as farmers we are in accord with the Senator's efforts to at least minimize this evil. That there is much financial distress among the wheat growing farmers due to the present low prices, we fully agree with the Senator, but we do not agree that the remedy resides in a special session of Congress or buying of wheat by a governmental agency with a view of stabilizing price. The government, through Congressional action, has no more right to fix the price of wheat than it has to regulate the price of chewing gum, jewelry, food, clothing, lumber, medicine or any necessity of life, for the common sense, plain business reason, that the fluctuating laws of supply and demand govern this automatically.

In discussing the above feature the Senator made one very frank statement which might well be considered not only a confession, but which in the final analysis may be held to also embody the answer to a large majority of the trouble complained of by the wheat farmer, the agriculturist in general, the wage worker and tradesman in most all lines of activity, which was as follows:

"Of course," says the Senator, "during the time of high prices we farmers got to speculating, with wheat at $2.50 per bushel, hogs at $18.00 to $19.00 per 100 lbs., and butter 80c per lb., we overreached ourselves, and when deflation set in with falling prices we could not meet our obligations."

The answer to much of the farmers' troubles, and other workers who have been caught in the readjustment of values since the war is that, as the Senator fortunately confessed, they got to speculating, as the Senator admitted, and many of them by their unbusinesslike plunging practically mortgaged their present and future income on a basis of war prices, the duration of which *no one knew*, consequently when deflation set in, and their creditors with a reduced margin of security, pressed for settlement, there was only one answer, "*Sell at a Loss and Settle,*" and to assume the remedy is vested in Congress, or that the railroads are to blame, is so unbusinesslike as to be almost foolish.

Again, one of the principal factors operating to the advantage of the wheat grower at the present time is one largely of his own creation, which the Senator should have discovered and given publicity to in his public utterances, and that is the inexorable laws of "Supply and Demand" which are well known to all fair minded people of ordinary intelligence, which means that the farmers must guard against over-production if they expect to enjoy fair prices, and this they not only failed to do but deliberately went ahead and put in about 5,000,000 or 6,000,000 acres more of wheat than was needed, from which there could be only one result, over-production of the world's market and low prices, but Senator Johnson either has not informed himself on this phase of the situation, or he prefers not to admit is as a fundamental factor in the case.

It seems not inappropriate to here mention that about the time Senator Johnson came to this country, a somewhat similar situation arose in the great corn growing states of the Mississippi Valley finally resulting in political upheaval particularly in Kansas.

The corn growers of the world increased their acreage until corn was a drug on the market and in Kansas where it sold down to about 10c per bushel thousands of farmers used corn as fuel in place of coal and hundreds of farm mortgages predicated on good prices for corn were foreclosed and much suffering resulted. Politicians at once saw their chance to capitalize a misfortune for which the government or any corporate interest, was in any way responsible. The railroads and political party in power, however, were charged with responsibility for the mistakes of the corn producers of the world, the public mind was poisoned with this insidious propaganda and a political upheaval followed. Loyal, faithful and efficient public servants were turned out and others untried put in their places, the agriculturist changed their crops thus reducing the corn acreage, the price of corn went up and the politicians then in power said, "See, *we* have saved the corn farmer" when as a matter of fact they didn't have a thing to do with it. The corn producers effected their own remedy by reducing the acreage, a thing which they could have easily foreseen and protected themselves against.

The Senator feels that our railways are inefficiently managed and have made little or no progress in twenty years, and in this we are quite sure he has fallen into a most grievous error. It is not uncommon, however, for men when elected to high office, to at once place their judgment, on matters with which they have had no experience whatever, above that of experts in a particular calling or profession to which their lives have been devoted, and we feel that the Senator could well profit by the counsel and advice of some of the successful managers of railway properties on such questions as may come before the body of which he is now a member.

The outstanding feature of the entire address was the complete failure of Senator Johnson to offer *any* constructive plan for remedying the conditions of which he so bitterly complains.

Railway and Locomotive Engineering hopes United States Senator Magnus Johnson may become as proficient in dealing with national problems as he has in those to which he has been accustomed in his own state.

Corrections

Letters to the Editor

To the Editor:

I have before me a copy of Railway and Locomotive Engineering for September and note the abstract beginning on page 276, of the report of this Bureau on Transverse Fissures in Steel Rails.

The sub-title of this article reads: "The causes of rail breakage as developed by the Bureau of Standards." Permit me to call attention to the fact that the Bureau of Standards has nothing whatever to do with the preparation of this report or in the investigations forming the basis of this report. This report covers investigations conducted by the Bureau of Safety and it is respectfully requested that you give this Bureau due credit for the report by publishing a correction in the forthcoming copy of your magazine.

W. H. Borland.

Director, Bureau of Safety, Interstate Commerce Commission, Washington, D. C.

To the Editor:

In the August issue of the Railway and Locomotive Engineering, I notice on page 251, a very interesting article entitled "Locomotive Development as Evidenced by Sustained Efficiency and Long Runs." Permit me to call attention to an omission of one important continuous run on the Southern Pacific which has been a daily performance for the past ten years, namely, from Del Rio, Texas, to El Paso, Texas, a distance of 451 miles, three crews being required on the run.

On page 265 an article entitled "Testimonial to Mr. S. M. Vauclain" it is stated that the Prosperity Special, consisting of thirty-five (35) new locomotives for the Southern Pacific Company, operated as a special train from Philadelphia to Houston, Texas. As a matter of fact this train was operated intact through to Los Angeles.

J. A. Power,

Superintendent of Motive Power and Equipment, Southern Pacific Lines, Houston, Texas.

Institute to Probe Railroad Questions

Definite findings in a survey of what he states are the three most pressing railway questions before the public will be ready to be presented to the people before the time of the Presidential conventions next summer. It was announced today by Dr. David Friday, former president of Michigan Agricultural College, director of the research council of the National Transportation Institute.

According to Dr. Friday, the subjects for study have been divided into seven divisions, as follows:

Study of railway rates with reference to amount invested in roads; effects of transportation costs on prices, especially of farm products; distribution of freight rates on the geographical distribution of industry; relative efficiency of private and government owned roads; relation of investment in railroad securities to value of properties; study and review of Interstate Commerce Commission valuation of roads.

Improved Shop Devices for Railroad Work

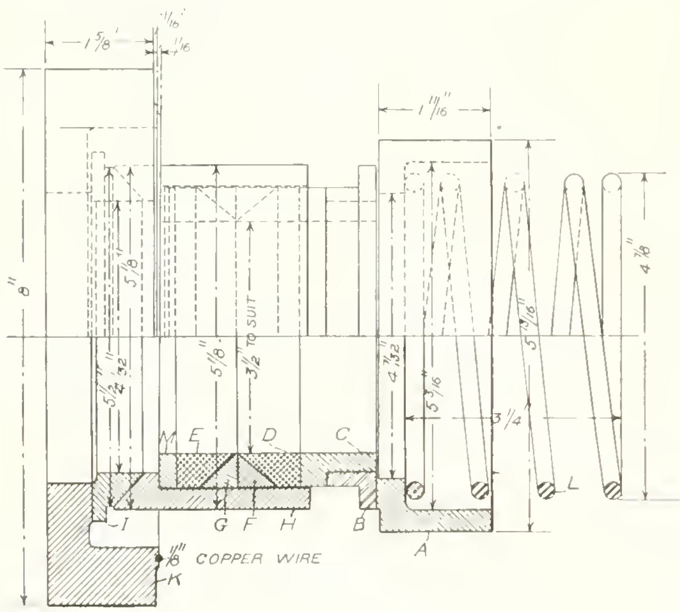
Gary Piston Rod Packing—A Test Rack for Air Pump—Wheel Inspector's Gauge—Flue Beading Tool

The Gary Piston Rod Packing

The piston rod packing here illustrated was designed by S. L. Gary, foreman of the machine shop of the Chesapeake of Ohio Ry. at Richmond, Va., and is in general use upon that road.

The claims made for it are that it forms a steam tight joint around the piston rod and prevents any blowing of steam. Because of this, a smaller amount of lubricant is needed in both the cylinder and on the guides than would, otherwise, be the case. As there is no blowing of steam the guides can always be kept properly lubricated, with the result that there is less wear on the cross head babbitt lining than where imperfect lubrication prevails; thus saving the cost of frequent relining.

Further, this packing does not wear the piston rod



Gary Piston Rod Packing

to a taper or out of round, which saves the cost of returning the rod.

There are few parts which need to be renewed, thus making the maintenance cost very low. And in the summing up of these advantages, it is claimed that it will save money in oil, babbitt, piston rods, packing, time and worry.

Referring to the illustration of the packing, the spring *L* is at the inner end and is seated in the spring case *A*, which is turned to an outside diameter 1/32 in. less than the inside diameter of the stuffing box. It is so applied that the spring case comes to within ⅛ in. of the bottom of the stuffing box in which it fits, so that the tension of the spring holds all of the joints neatly and properly together. Then, too, when the pressure of the steam comes into contact with the spring case, it causes the packing to automatically tighten the joint because of the excess pressure and thus secure an absolutely tight piston rod packing.

The ring *B* against which the spring case *A* bears, is of steel and has a smooth flat joint, so that it can slide freely in any direction on the spring case. It also serves as a retaining ring, for holding the section *C* portion of the push ring in place. This latter is of brass and is made in two pieces, so as to permit of application to a rod having a large crosshead fit.

The push ring *C* has a direct bearing on the alloy ring *D* of the packing proper. This consists of the four parts *D*, *E*, *F* and *G*. These are held between the push ring *C* and the head packing ring *M* which is made of brass. These four pieces are so beveled that as they are pressed together by the push ring, under the action of the spring, the two end rings, *D* and *E*, are crowded in against the piston rod, while the two center rings, *F* and *G*, are forced out against the inside of the vibrating cup *H*, thus forming tight joints between these two surfaces.

The vibrating cup *H* is made in the form of a solid ring and is of soft steel or cast iron and is turned to at least ⅝ in. or ¾ in. smaller than the bore of the stuffing box. The outer end of the vibrating cup is in the form of a ground ball joint having a bearing against the flexible head ring *I*. This flexible head ring is a ground joint ring with a flat joint on one side which is ground against the packing gland *K* on one side and, with the other, a ball joint ground to the end of the vibrating cup *H*.

This ring is one of the most important of the features for obtaining an absolutely tight and serviceable packing. This, because the flat joint can move up and down freely when a crosshead is somewhat loose in its guides, and, at the same time, the ball joint permits the vibrating cup to oscillate, should the piston rod in operation, become out of line. So that it can do this without throwing any undue stress upon the alloy packing and breaking it loose in the cup.

The whole is kept in place by the gland *K* which is bolted against the back cylinder head, and made tight by means of a ⅛ in. copper wire joint.

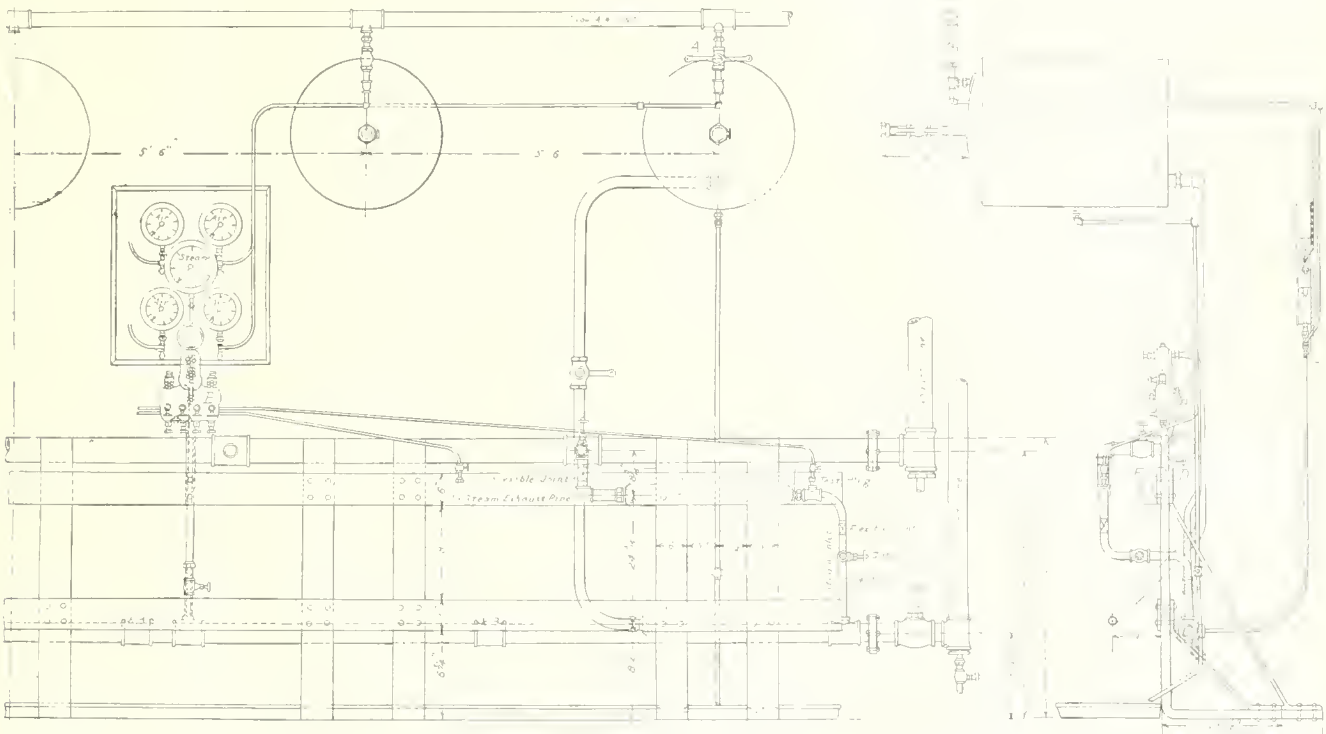
The steam tight joints, therefore, are made by the copper wire between the gland *K* and the cylinder head; the ground flat joint between the gland *K* and the flexible ring *I*; the ground ball joint between the flexible head ring *I* and the vibrating cup *H*, and the bearing between the alloy packing rings and the piston rod and vibrating cup respectively.

Test Rack for Compound Air Pump

A description was published in the March, 1922, issue of Railway and Locomotive Engineering of a test rack for the 9½ in. air compressor. The same railroad that stood sponsor for it has one also that is adapted to work on the compound compressor. It is of the same general arrangement, but with a greater elaboration of detail.

As in the case of the 9½ in. rack this one is capable of an indefinite extension to accommodate as many pumps as may be desired. The shop air line is carried overhead along the length of the rack, and is connected to the drums that represent the main reservoirs on the locomotive. The connection between the shop line and the reservoirs can be opened or closed by means of the long handled cocks *A*, to which chains reaching to the floor are attached. By opening the connection, when the pumps are at work, they are made to compress against the shop system pressure and the air delivered is available for utilization elsewhere. When closed, the pump delivers direct to the drums and an orifice test is possible.

There is a panel board near the center of the rack carrying four air pressure gauges that are connected, one to each drum, and a steam gauge connected to the main steam supply line. It will be seen that there is a drum for each pump. Beneath the panel there is a four-feed



Test Rack for Compound Air Pump

hydrostatic lubricator *B*, with pipes leading to the right and left to the pumps.

The steam and exhaust pipes run along the back of the rack at the bottom and top respectively, and are marked *C* and *D* on the end elevation.

The racks for holding the pumps are made of 6 in. by 2 in. flat steel bent to an L shape and braced with ¾ in. diagonals of the same width.

The pumps are carried by the brackets *E*, on which they are hung by means of their brackets. Very little adjustment of the pumps to place is needed as the piping for both the air and steam connections is fitted with flexible joints so that the couplings can be brought into contact and fastened without trouble.

Inspector's Gauge for Mounted Steel Wheels

After steel wheels have been mounted it is necessary that they should be inspected in regard to the distance between their inside faces. The gauge illustrated is a light device that is in use on the Chesapeake & Ohio Railway and enables the inspector to go over a number of pairs of wheels with great rapidity.

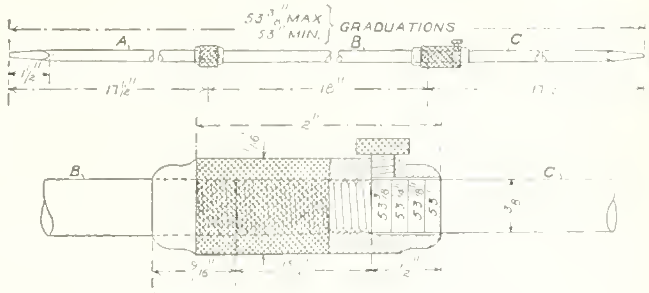
It is formed of three steel bars of ⅜-in. diameter. The two end bars are drawn down to a diameter of ¼ in. for making a ready and close contact with the face of the wheel. The bars *A* and *B* are connected by an ordinary brass nut by which an adjustment of the total length can be made.

The bars *B* and *C* are coupled by a special nut, as shown in the detail engraving.

This detail shows the center rod *B* screwed into the brass nut at one end of the latter and the end rod *C* screwed into the other. It will be seen that the nut is counterbored to receive a smooth portion of the rod *C*, and that the portion of the rod entering this counter-bore is scaled off to 53 in., 53⅛ in., 53¼ in. and 53⅜ in., and can be held in place by a lock screw.

This scale makes it possible to caliper the distance between the inside faces of the wheels very accurately.

The lock screw is loosened and the end *C* screwed out until the two ends of the gauge are in contact with the inside faces of the wheels. Then the lock screw is tight-



Inspector's Gauge for Mounted Steel Wheels

ened and the distance read on the scale on the rod *C*, which reads accurately to ⅛ in., and can be estimated to 1/16 in. or even 1/32 in.

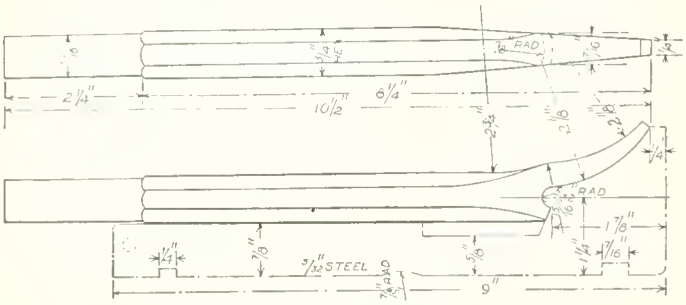
Flue Beading Tool

The accompanying illustration shows with full detail measurements of the standard flue beading tool that has been found to be very efficient and satisfactory upon the Chesapeake & Ohio Ry.

It is 10½ in. long over all and is made of hexagon steel. The forming curve is of 5/32 in. radius so as to form a 5/16 in. bead at the end of the tube and the heel and toe are cut at such an angle and given the proper curve to facilitate the upsetting and belling of the end of the tube so as to put it in shape for the final beading.

In connection with the beading tool a template for making it is also provided. This is shown by dotted lines as lying against one side of the lower drawing of the tool. It has a bevel that bears against the heel with a projection fitting into the beading groove and then fits against the curve up to the tip that serves as a fulcrum for the belling out of the tube.

On the lower face of the template there are three grooves: one 1/4 in. wide, one 7/16 in. wide and one cut

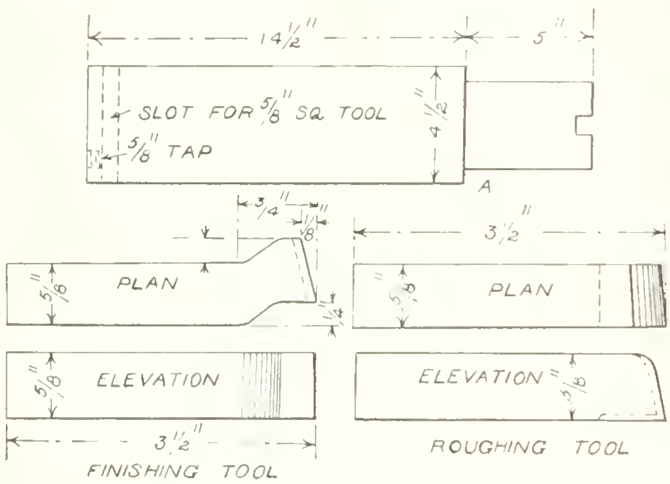


Flue Beading Tool

to a radius of 7/8 in. These serve respectively for bringing the tip and heel to proper widths and the heel to a proper radius. It is thus possible to make all of these tools alike and with the minimum of trouble.

Tool Bar and Tools for Boring Driving Boxes

The tool bar and tools here illustrated are those used on a boring machine on the Chesapeake & Ohio Railway for boring driving boxes. The principal object of interest in the combination lies in the shape of the roughing and finishing tools. These are shown very clearly by the



Tool Bar and Tools for Boring Driving Boxes

engraving, and attention is particularly called to the position of the cutting edge relatively to the supporting faces of the body of the tool and the clearance of the finishing tool.

As to the tool holder the principal point to be looked to is that it should fit the head and have a perfect bearing on the shoulder *H*.

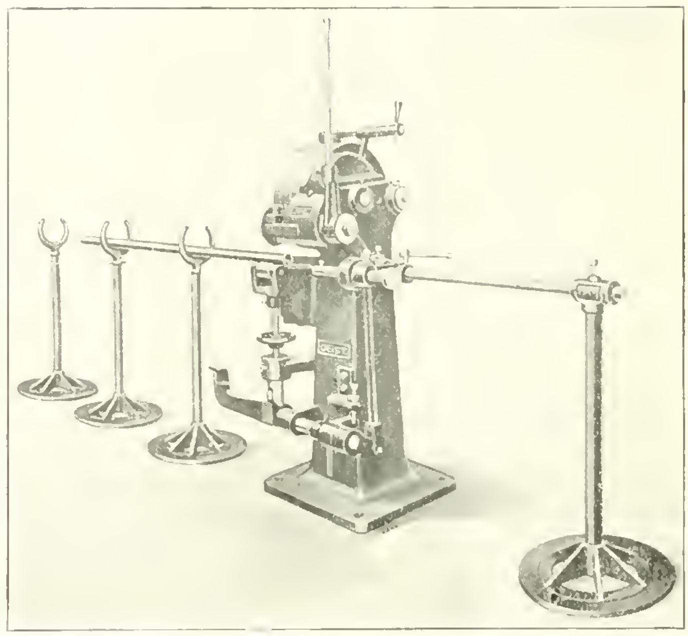
Heavy Duty Roller Pipe Cutter

The Geist Manufacturing Company, Waynesboro, Pa., has placed upon the market a high production heavy duty roller pipe cutter. The design of this machine embodies features which have eliminated certain weaknesses generally found in machines of this type. This machine is made in one size, namely No. 2, having a range from 1/8" to 2" inclusive.

The cutter is made from tool steel and heat treated to give the maximum wearing qualities. It can be reground when dull. The cutter shaft bearing is provided with an adjustable cap on the cutter side for taking up any wear which may occur. This is distinctive to the Geist Roller Pipe Cutter and adds greatly to the life of the machine.

The rollers are made from tempered tool steel and are carried in roller bearings. The cage which supports the rollers is elevated to the cutter by a cam operated jointly by a pedal and a lever. The sliding surfaces of the cage are protected from scale and dirt by a flexible guard. The rollers are adjustable for the different sizes of pipe. This adjustment is obtained by means of a hand wheel located just below the rollers. The lever and the pedal can be positioned to suit the operator. Their movements are limited by an adjustable stop. A small cage of rollers for 1/8" to 3/8" pipe can be attached to the large cage without removing the regular rollers.

The length gauge is adjustable for the different sizes and lengths of pipe. It will gauge lengths of pipe up to and including 4 feet. The parts coming in contact with


Heavy Duty Roller Pipe Cutter

the revolving pipe are hardened to resist wear. The gauge arm is a heavy casting and will resist flexure.

The machine is compact and rigid in design. All spindles and shafts are ground and run in bronze bushed bearings. The gears are enclosed, but are accessible at all times.

This machine is sold by the Landis Machine Company, Waynesboro, Penna. Inquiries and requests for further information may be addressed to them.

Railway Business Association Meeting

The annual meeting and banquet of the Railway Business Association will be held at Hotel Commodore, New York, on November 8. Among the speakers at the dinner will be Julius Kruttschnitt, chairman of the Southern Pacific Company, and James R. Howard, president of the National Transportation Institute.

The business sessions will be held during the day and the banquet in the evening. The price of the dinner tickets this year is $9.00, and applications may be made to Frank W. Noxon, 600 Liberty Building, Philadelphia, Pa.

The Forerunners of High Speed Trains

Early Performances on the Pennsylvania Railroad and the Fundamental Principles for the Operation of Fast Trains

By GEO. L. FOWLER

It was almost about 1874 or 1875 that the demand for greater speed and higher efficiency in locomotive work began to be demanded; a demand that has been increasing ever since. The first step towards the meeting this demand lay in so building a locomotive as to increase the amount of work done per unit. This involved the construction of larger locomotives than had been built before and a corresponding increase in the cars with which the several parts were proportioned. The demand for this increase of service and efficiency was accentuated by the travel to the Centennial Exposition held in Philadelphia in 1876. Nearly all of which was carried by the Pennsylvania R. R. A demand that was carried forward into all the years that have followed.

Some remarkable locomotive performances were made during that year, not the least of which was the running of the widely heralded Jarrett & Palmer theatre train from New York to San Francisco carrying an opera company under the management of these gentlemen.

It fell to the lot of the motive power department to provide the locomotive that was to haul this train from New York to Pittsburgh.

The circumstances were these: Jarrett & Palmer, who were, then, 1876, the leading theatrical managers in New York, wanted, for purely advertising purposes, to have their opera company taken from New York to San Francisco, 3,313 miles, in 84 hours. The Pennsylvania R. R. agreed to assist in the matter, and that it, too, might reap something from it, the suggestion was made by Mr. Frank Thomson that the run should be made from Jersey City to Pittsburgh, 438 miles, without a stop. It was an unprecedented thing to do and required careful preparation. The main problem was how the locomotive could be furnished with sufficient coal and water and to fit up the train that, in case anything should get hot, it could be attended to without stopping. In the selection of a locomotive to haul this train, Mr. Theodore N. Ely, the superintendent of motive power, took one that was in service and had been for a considerable time. He did not allow anything to be done to it in the way of repairs or overhauling, no resetting or readjusting of bearings or journals nor anything of the kind; his theory being that there was no reason why a locomotive which had been running for a long time satisfactorily, should not so continue to run, whereas one that had just been overhauled would suffer from ailments so common to locomotives just out of the shop.

Then a computation was made of the amount of coal and water that would be needed between the watering troughs, and this was necessary because the troughs were located so as to meet the wants of each division and not with reference to a through run from one end of the road to the other, which made the gaps between the water troughs of too great a length without an additional supply. This additional supply was met by providing a baggage and combination car in which the extra amount needed could be carried. On the official run at the start there were about 130 bushels of coal and 2,400 gallons of water in the tender; 75 bushels of coal and 2,400 gallons of water in the baggage car and 50 bushels of coal in the combination car. After passing Philadelphia, coal and water was used from the baggage car in order to lighten it. The water was then put back in the baggage car and the tender filled, in this way keeping up the supply. And later after passing Lewiston Junction, 256 miles from Jersey City, all of the coal in the baggage car was put in the tender. After all of these preliminaries had been provided for, they decided to have a full dress rehearsal and try the experiment of running the train from Pittsburgh to Jersey City without stopping, which could be very conveniently done, as the locomotive selected for the work came from the Pittsburgh Division. The start was made from Pittsburgh at six in the morning, and Jersey City was reached late in the afternoon, the whole run of 438 miles having been made by daylight.

The train was held during the next day, being carefully watched to see that no tampering took place with the machinery, either cars or locomotive, and was started on the return trip with the opera company on board, a few minutes after midnight.

On its west-bound trip, or the one made under the gaze of the public, everything went smoothly until some defect developed in the brake mechanism on the west slope of the Alleghenies beyond Cresson, which caused the train to run at a very high speed. However, nothing sensational occurred, and Pittsburgh was reached on schedule time. The time consumed was ten hours and five minutes for the run or an average speed of forty-three and one-half miles an hour. William Phillips was the engineer.

On both runs a pilot engineer for each division was in the cab, and on going east, on the trial run, he failed to notify Phillips of a five degree curve on the Coatsville bridge on the Philadelphia Division. The result was that the curve was passed at so high a speed it seemed to those on board that the wheels were lifted from the inner rail.

This may be taken as forerunner of the present day, high-speed limited trains, and is an example of the care and forethought that attended all unusual work upon the line.

In this connection a presentation of Mr. Ely's personal ideas on the subject of the requirements for a high speed traffic is of interest.

In 1892, in an article contributed to *Scribner's Magazine*, he presented certain requirements for safe high speed travel which set forth the fundamental principles underlying the possibilities of such work, and which will be apropos to the situation so long as the subject may be open for discussion. He first called attention to the fact that the possible speed of locomotives had not been improved in fifteen or twenty years. That the records showed that the locomotives of that early date had made, on occasions, as fast runs with trains within their capacity as those of most recent dates. He then went on to say that "from the lesson of the past we may forecast the future for certainly we have reached that stage in railway progress where we may assert with confidence that our acts and opinions are based upon accumulated experience and not upon prophetic light, let us consider what factor will control the limit of speed in the passenger trains of the future."

"In the road-bed we shall have to demand that the alinement be almost free from curvature, and the width between the tracks be increased; that the foundation shall be stable and well protected from rain and frost; that land-slides and other obstructions shall be provided for; that the rails shall be heavy—one hundred pounds or more, if necessary—and securely fastened; that all frogs and switches shall be proof against accidental misplacement or rupture; that all drawbridges shall be secure beyond question, and finally, that all crossings at grades be abolished. We must further insist that a thorough system of supervision and inspection shall be carried out.

"With a fulfillment of these conditions, which, professionally speaking, are perfectly practicable, trains so far as the road is concerned may be run as fast as any locomotive can be made to haul them.

"Of the locomotive it may be said that only with the improvements in road-bed referred to, can its highest attainable speed be utilized.

"The measure of the speed and capacity of the locomotive rests in the firebox, the length and breadth of which cannot exceed certain dimensions. It therefore follows that when this furnace is arranged to burn the maximum quantity of fuel, the steam-producing limit will be reached, and with it the limit of speed. But this steam must be used to the very best advantages, as relating to the proportions of the locomotive, as well as to its type; the first of these are already well known, and it will probably be found that some of the compounding will suggest the type." The reader will remember that this was written before the first development of the superheater. "With these limitations the speed of locomotives with passenger trains will not fall short of 100 miles an hour; by which is meant a sustained speed at that rate, as, for instance, a trip between New York and Philadelphia in about one hour; or between New York and Chicago in ten or eleven hours.

"As to car equipment, it is probable that with some change in size and proportions of wheels, journals, and other parts of the trucks, the best class of cars in present use would be suitable for the highest speed. They should be made to run as noiselessly as possible, that the occupants may be relieved from any feeling of insecurity or nervous strain. The air brake should be applied in the best form to both locomotives and cars, so that every pound of brake weight should become instantly available.

"The above conditions have been cited in detail to show that they all must be fulfilled in order to make possible future traveling at the rate of 100 miles an hour. Make possible yes, but only on the fulfillment of one other condition, namely, a clear track ahead; and this it is which brings us to the real measure of speed, which is the question of transportation in its strict sense. This limit will vary with the number of trains already on the line and with the facilities for handling them. First of all, we must know how soon after receiving warning of danger a train, running a mile in thirty-six seconds, can be stopped. It is estimated that, if running at sixty miles an hour with the full braking weight of the train utilized, and rails in the most favorable condition, the train could be brought to a full stop in 900 feet; at eighty miles an hour in 1,600 feet; at ninety miles an hour, in 2,025 feet; and finally at 100 miles an hour, in 2,500 feet. These figures at once established the fact that, under the best possible conditions the track must be kept clear of all obstructions for at least 2,500 feet in advance of a train running at the highest speed limit; but we must estimate the clearance for the worst conditions, such as slippery rails, foggy weather and unfavorable grades; the personal equation of the engineman must also be considered in a train covering 145 feet each second.

"Would it, therefore, be too much to ask that the engineman receive his warning at least three-quarters of a mile before he must halt?

"The difficulties of arranging for the passage of trains of this character are manifest; we are not speaking of special trains, but rather of regular trains, running as frequently as may be desired. It should be remembered that in a two-hour run, the fastest trains of today would require a leeway of an hour, and slower trains would have to start proportionally earlier, or be passed on the way.

"The most improved forms of signaling and interlocking be they mechanical, pneumatic, electric, automatic or otherwise, which are so necessary to the safe movement of passenger trains, may be introduced but cannot be placed nearer together than three-quarters of a mile. The very presence of these signals, while giving the maximum of safety, has in practice, made prompt movement more difficult. They are governed by fixed laws which, if obeyed, make chance-taking impossible, for trains must keep a prescribed distance apart, and increase in speed, involves greater intervals. This state of affairs would point to the necessity for an increase in the number of tracks, so that passenger trains could be grouped on the basis of speed, just as it has been found necessary already on crowded lines to separate the freight traffic from the passenger.

"If this be done, and unlimited track facilities are furnished, the prompt dispatching of trains would be the ultimate measure of speed; but such an outlay would be beyond all reason. It is fair, therefore, we think, to rest the burden upon the transportation shoulders, and predict that with it, and it alone, lies the practical limit of railway trains drawn by steam locomotives."

It will be seen that the whole attitude of this article was that, if high speeds are to be attained, it is necessary that special preparations shall be made therefor. It was in marked contrast to the position assumed by the officers of some other roads, that to run at high speeds, it was merely necessary to put a locomotive and train upon the rails and run it. Forethought and preparation is required in this way in every other walk in life, and all experience bears out the wisdom of taking thought. It has been argued that the one hundred miles an hour train would be safer than the forty or fifty miles an hour train, because more pains would be taken to make it safe. Surely an argument of one who was not a thorough railroad man or it would not have been admitted that every precaution was not always taken to make travel safe. But the danger was early recognized and few know how close to the breaking point these high speed trains are running.

Great as was the Jarrett & Palmer achievement it fell far short of what was to come, but it paved the way for greater developments. The work during the Centennial, year convinced the railroad world of the possibilities of the locomotive that had never been realized before.

Rate of Return on Investment Accounts

The net operating income of the Class I railroads by sub-districts in the first seven months of this year has been as follows in the table below. The rates of return which these earnings represent, according to compilation of the Bureau of Railway Economics, also given below, is based on the property investment accounts of the roads, because the Interstate Commerce Commission has not yet given out sub-district tentative valuatons.

District	Investment	Pct.
New England	$7,608,000	1.58
Great Lakes	117,733,300	6.45
Ohio-Ind.-Alleg	134,541,400	5.96
Pocahontas	28,601,250	6.17
Southern	77,624,750	5.48
Northwestern	39,807,000	2.56
Central Western	87,676,960	4.45
Southwestern	34,626,550	3.54

Universal Brake Control and Other Types of Brakes

Abstract of a Committee's Report to the Traveling Engineers' Association

The history of the art of controlling passenger trains by power brakes may be divided into periods—first, that from the hand to the straight air brake; second, the plain automatic to the high speed brake; third, from the first type of graduated release to the present highly developed electrically controlled brake.

In making comparisons between the various types it must be borne in mind that each in its particular period served well its purpose, and the fact that the highly efficient brake of the present embodies some of the features of the first automatic brake of 1872 shows how well first principles were laid down by the inventor. Too high tribute cannot be paid to the inventor of such a combination of brake cylinder, triple valve and auxiliary reservoir, which has stood the test of fifty years' development of railroad rolling stock.

The development of brakes has been brought about by a definite need to meet the rapidly increasing demand for transportation and to bring about certain necessary results, the end in view being the safety of life and property and making possible increased traffic with minimum cost.

Conditions to be met and objects to be attained may be summarized as follows:

Conditions: Increased weights, higher running speeds and greater frequency of trains.

Objects to be attained: 1. Much more flexible control of the train, greatly reducing possibility of shocks. 2. More uniform braking power. 3. Constantly recharging auxiliary reservoirs, which increases safety. 4. Better protection against excessive braking power in service applications. 5. Shorter, smoother and more accurate stops.

An up-to-date power brake must be reliable, flexible and effective. Reliable in that it must operate when required, and if there are any failures they will be on the side of safety. Flexible, in that certain retarding force between a minimum and fixed maximum can be obtained as conditions require. Effective, in that it will result in a moving train being brought to rest in a reasonably short distance.

P. M. Equipment

This equipment, first introduced in 1887, was known as the quick action brake to differentiate it from the plain automatic brake in 1872. With the volume of air necessary on cars then in use and 70 pounds pressure in brake pipe and auxiliary reservoir, the service and emergency functions were brought about uniformly enough to avoid dangerous shocks. As cars became heavier, speeds higher and service more frequent it became necessary to obtain more flexibility and power to stop. Improvement was brought about by increasing the pressure carried from 70 pounds to 110 pounds and adding to the equipment what is known as the High Speed Reducing Valve, which is attached to the brake cylinder. This equipment introduced in 1894 is known as the High Speed Brake and a short description of its functions follows: It comprises an "M" type brake cylinder, of size suitable to the weight of car, with an automatic slack adjuster set for eight-inch running travel, an auxiliary reservoir, a P-1 or P-2 quick action triple valve, dirt collector, cut-out cock, angle cocks, etc. The triple valve controls the flow of air: (a) from the brake pipe to the auxiliary reservoir for charging the system; (b) from the auxiliary reservoir to the brake cylinder for applying the brakes in service application (c) from the brake cylinder to the atmosphere when releasing; (d) from the brake pipe and auxiliary reservoir to the brake cylinder when a quick action or emergency application is desired. A high speed reducing valve, connected to brake cylinder, adjusted to retain sixty pounds, acts as a safety valve during service applications. In emergency applications this valve permits the brake cylinder pressure to reach its maximum and then by an ingenious arrangement of blow down reduces the cylinder pressure to sixty pounds as the brakes become more effective as speed is reduced.

With modern cars, with large brake cylinders and long trains the use of P. M. equipment is undesirable, because: (a) its function is materially affected by length of train and condition of valves; (b) effective service applications cannot be obtained in quick succession due to the recharge all coming from brake pipe; (c) of the liability of undesired quick action due to the same piston controlling both service and emergency functions; (d) of the inability to obtain quick action after a service application; (e) of the possibility of brakes creeping on due to fluctuations of brake pipe pressure; (f) of the possible loss of braking pressure without warning; (g) of the necessity of using valves of different size for various size brake cylinders.

L. N. Equipment

The P. M. equipment gave satisfactory service until the railways put into use passenger cars requiring brake cylinders 16 to 18 inches in diameter with proportionate size auxiliary reservoirs. Necessity for improved brake control was thus brought about.

The large brake cylinders and auxiliary reservoirs meant greater volumes of air to handle in a given time. Also, it was necessary on account of the increased length of trains, to obtain means whereby a more uniform service application be made, and to obtain a better control of the release of brakes. It was to meet these varying conditions and requirements that the L. N. type of equipment was developed and put in use in 1908. The equipment consists of a type "L" triple valve, which has a safety valve attached, type "N" brake cylinder with pressure head arranged for all pipe connection, auxiliary reservoir, supplementary reservoir and necessary cut-out cocks, conductor's valve, etc. It has the same general features of the P. M. equipment, with the following added: (a) quick service; (b) graduated release; (c) quick recharge of auxiliary reservoir; (d) high brake force in emergency.

Long trains made apparent the disadvantage of having all the brake pipe reduction for service application made through the brake pipe exhaust port in the brake valve. This condition made service brake applications too slow. The quick service port in the "L" triple valve reduces brake pipe pressure locally at each valve, venting to the brake cylinder, thus insuring the reduction being made at such a rate as will cause all brakes to apply promptly.

When an emergency application is made the air in the supplementary reservoir, which is approximately two and one-half times the volume of the auxiliary, combines with the auxiliary reservoir and with the pressure coming from the brake pipe through the quick action portion of the triple valve to produce a high cylinder pressure. This is retained throughout the stop due to the safety valve not being in communication with the brake cylinder during emergency application.

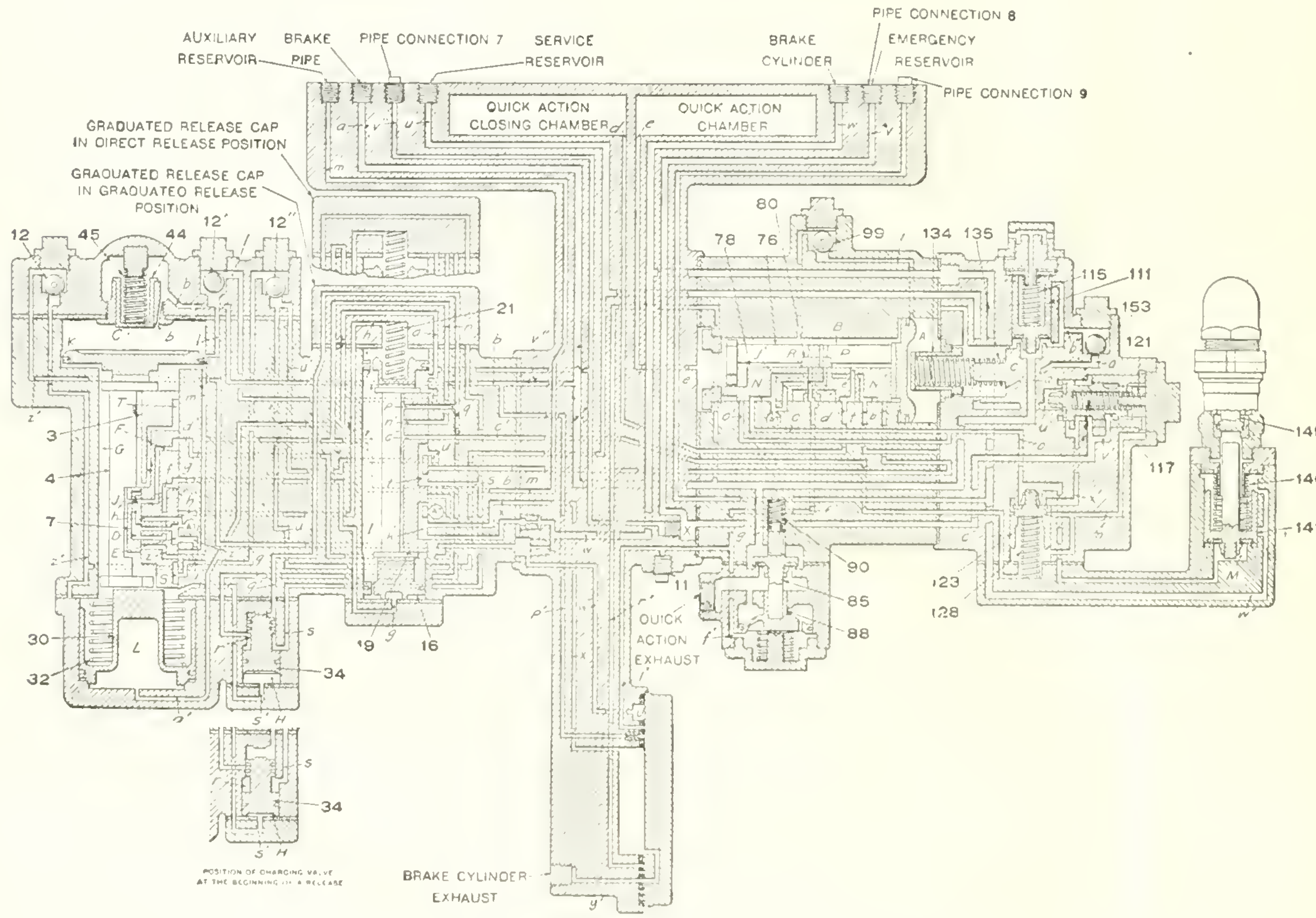
When "L. N." equipment is used in trains with "P. M." equipment it is the practice on some roads to have the supplementary reservoirs cut out. When this is done the graduated release, quick recharge and high pressure in emergency features are lost.

The "L" triple valve is a pipeless triple valve, which is quite a convenience to the inspectors and air brake repairmen, inasmuch as it can be removed from the car without having to disconnect any of the pipes. The requirements are that triple valves must not be cleaned while attached to the car, but be removed and taken to the air brake repair room or other suitable place, where after cleaning they can be tested on a proper test rack.

sure against leakage; (f) limiting of service brake force to a predetermined amount; (g) service and emergency features widely separated, although controlled by the same piston; (h) automatic emergency when brake pipe pressure is depleted; (i) emergency brake force obtainable at any time.

This equipment was only used on a few railroads and did not come into general use.

The U. C. equipment was designed and introduced for the same reasons as brought out the P. C. equipment and it contains all of its essential features, so space will not be taken up with any detailed explanation of P. C. equipment. The explanation of the U. C. equipment which follows will cover the general features of the P. C.



A Diagrammatic Drawing of the U-12 Valve In Which the Principal Parts Are Indicated as Follows:

4—Equalizing piston.
7—Equalizing graduating valve.
3—Equalizing slide valve.
19—Release slide valve.
16—Release piston.
44—Equalizing piston stop.
12—Service port check valve.
12′—Emergency reservoir charging check valve.
12″—Service reservoir check valve.
30—Graduated release piston.
34—Service reservoir charging valve.
123—High pressure valve.
78—Emergency slide valve.
99—Quick action chamber charging check valve.
76—Emergency piston.
80—Emergency graduating valve.
88—Quick action piston.
141—Cut-off valve.
85—Quick action valve.
111—Protection valve.
134—Emergency piston stop.
117—Intercepting valve.
149—Safety valve.
153—Emergency check valve.

P. C. Equipment

The P. C. equipment was designed to meet the demand made on the air brake by the introduction of cars weighing 120,000 pounds or more. Heavier cars brought about the adoption of heavier and more powerful locomotives and the average speed of trains was increased. All this required a more efficient brake.

This equipment possessed all the features of the older types with the following additional features: (a) Fixed flexibility for service operations; (b) certainty and uniformity of service operations; (c) quick rise in brake cylinder pressure; (d) uniform brake cylinder pressure independent of piston travel; (e) maintenance of brake cylinder pres-

Universal Brake Equipment

The U. C. equipment is made up of the following parts: One U-12 universal valve; one auxiliary reservoir; one service reservoir; one emergency reservoir (when two brake cylinders are required two emergency reservoirs are used); one brake cylinder (two brake cylinders are used when car weight exceeds 153,000 pounds); one conductor's valve; one centrifugal dirt collector; the necessary cut-out cocks, angle cocks, hose couplings, etc.

The Universal Valve consists of the pipe bracket permanently bolted to the under-frame of the car, which has three faces to which are bolted (a) the equalizing portion which controls the charging and recharging of the reservoirs and the service application of the brakes, also the releasing of brakes; (b) the quick action portion with high pressure cap which controls the transmission of serial quick action and provides for high brake cylinder pressure in emergency application; (c) the electric portion, which comprises magnets, switch, etc., controlling the electric service and emergency applications of the brakes and electric release. (Note: If electric control is not used a blanking plate is bolted to the face of pipe bracket.)

There is only one size Universal Valve and it can be used on any weight car with brake cylinder varying from one-fourteenth inch to two-eighteenth inch with reservoir volumes to correspond. It is necessary to make provision for the admission to and exhaust of air from the brake cylinders at the proper rates. This is accomplished by the use of chokes in the passages leading to and from the cylinders.

Foundation Brake Rigging

In order to obtain all the benefit from Universal Brake Control it is essential that an efficient foundation brake gear be provided.

Up to recent years it was the prevailing practice to equip car trucks, of either the four or six wheel type, with brake rigging having but one brake shoe per wheel.

With such a brake rigging it is impossible to keep piston travel uniform. The shoe is hung below the center line of the wheel and when the brake is applied brake hangers are pulled down, piston travel is lengthened, thereby increasing cylinder volume. The result is cylinder pressure less than thould be obtained and longer time required to obtain it.

The disadvantages of using this type of gear may be summarized as follows:

(a) Rough handling in starting due to violent taking of slack; slowing down and stopping due to slack action in train caused by unequal piston travel.

(b) Inability to make time because of train pulling hard on account of short piston travel resulting in improper amount of shoe clearance and dragging brake shoes; long drawn out stops due to the engineer trying to avoid shocks by "dribbling" brakes on.

(c) Useless expense in excessive fuel and water consumption and reduced locomotive capacity due to the power necessary to overcome shoe friction; slid flat wheels due to uneven distribution of brake force; damage arising from shocks and "break-in-twos" as the result of short piston travel; hot boxes due to journal being pushed from under brass when brake is applied; burned brake shoes due to rubbing on wheel tread while brakes are released.

With a single shoe brake the shoe must absorb such an excessive amount of energy in stopping modern heavy steel cars that it is taxed beyond its capacity and wears away rapidly.

It is well known by those directly concerned in transportation matters that efficient handling of any train is the proper control of slack. All shocks are brought about by a sudden change of velocity of different vehicles in the same train, and the brake that will produce an effective retarding force with the least change in velocity between the front and rear portions of a train must be the best.

Such a brake is one that when a brake application is desired the brake pipe reduction and rise in cylinder pressure will occur simultaneously on each car in the train. The universal valve electrically controlled will do this efficiently and consistently.

Heavy vehicles, long trains and high speed have vastly increased the energy to be controlled by the brake and magnified the time involved in doing it. If modern trains are to be controlled in the same distance as the lighter trains of former years, it is necessary to use the best brake obtainable.

Anything developed for our comfort or convenience we may accept as a luxury at first, but on discovering its advantages we soon deem it a necessity. No one would consider the typewriter or telephone now as luxuries, but as necessities to carry on business. It is equally true of the Universal Brake Equipment. It is not a luxury, but a necessity, and that road is best equipped that uses the Universal Brake Equipment with an efficient foundation brake gear of the clasp type.

The committee presenting this report consisted of Messrs. Russell M. Smith, Chairman; H. H. Burns, E. F. Wentworth, J. R. Scott, Wm. Smith, and Jas. Fahey.

Locomotive Feed Water Heaters

Committee Report to the Traveling Engineers' Association

The committee, in preparing this paper, endeavored to obtain information concerning the feed water heater and exhaust injector from the different railways in Canada and the United States, but we found that a number of roads had not yet gone into the matter to any great extent. Other roads, however, who were using them, were only too willing to supply us with information, and in making out the paper we have tried to be as brief as possible, so that there will be sufficient time for discussion.

Feed water heaters utilizing exhaust steam from the cylinders offer the most attractive possibilities toward the further improvement in the efficiency of the steam locomotive of any of the devices now under consideration. While this subject has only been actively considered by the various mechanical associations for the past few years, it is far from a recent development even on a locomotive. Feed water heaters of various kinds were incorporated in some of the first locomotives to be used in this country. The soundness of the principle on which they are based was recognized by the pioneer builders, as well as those of today. However, because of the increased price of coal, their value today is many times greater than it was then and it is chiefly this reason that they are now coming into general use.

Upon investigation we find that there are three principal types of feed water heaters in general use, in which exhaust steam is used for heating boiler feed water. These are the open and closed type heater, and what is known as the exhaust steam injector.

Closed Type Heater

Briefly, the closed type heater consists of a simplex pump having a Westinghouse air compressor steam end driving a single water piston, which forces water through a heater separated from the pump. The heater consists of a series of small copper tubes expanded into heavy plates at either end, all enclosed in a cast iron body. The water passes through the tubes over the agitators placed in each tube and continues directly from the heater to the boiler check. In this heater there are no working parts or loose pieces. The condensate is conducted from the bottom of the heater to a filter located on the tender, where the oil is separated and the filtered and distilled water is discharged to the tank.

Open Type Heater

The open type heater consists of a combined heater and pump, so arranged that one steam cylinder drives two water pistons in separate cylinders, one of which draws cold water from the tender and discharges it through a spray valve in the top of the adjacent heater, and the other takes the hot water from the bottom of the heater and forces it into the boiler. In this type of heater the condensate is added to the feed water in the heater and since the quantity of this varies, it is necessary to incorporate within the heater a control device consisting of a large bucket type float and by-pass passages and valves to prevent the heater filling up in case there is formed more hot water than the lower pump can discharge. The oil is removed from the exhaust steam by a separator before it reaches the heater.

Exhaust Steam Injector

The exhaust steam injector, or the injector type open feed water heater, as the name implies, not only feeds the boiler by the use of exhaust steam, but delivers the feed water at temperatures varying from 200 to 220 degrees. Its operation is entirely automatic, as it operates with exhaust steam when the latter is available, and with live steam when the throttle is closed, without manipulation on the part of the enginemen. This feature of its operation is controlled by a differential piston, having its connection to the main steam pipe of the locomotive, steam pressure holding the live steam valve closed when the locomotive is using steam and when exhaust steam is available for working the injector.

The working of the injector is extremely simple, when instructions for its operation are understood, with either exhaust steam or live steam, and with the improved operating mechanism, no special instructions are required by enginemen, who are familiar with working any of the live steam injectors now in general use, as the operating parts are confined to a regulator and one lever, having four positions, namely; closed, priming, automatic and positive live steam position. The positive live steam position may be considered an emergency feature, since it is only required to operate the injector when the locomotive is standing with a pressure in the cylinders. An oil separator is used in the exhaust steam line for removing oil and other deposits in the exhaust steam before it reaches the injector.

The efficiency of the exhaust steam injector as a feed water heater, its simplicity of construction, flexibility and dependability, either when used as a feed water heater or a live steam injector, make it a very attractive means of boiler feeding. The fact that it will put water in the boiler against high pressures with less than 1 pound pressure, is one of its remarkable features.

When the locomotive is using steam and the injector operating with exhaust steam, it is essentially an open type heater, as the exhaust steam condenses in the water similar to other types of open heaters and the condensate is returned to the boiler; therefore, the economies that may be expected from its use are the same as with other heaters of this type.

While the exhaust steam injector for locomotive service is comparatively new in this country, there are a great many locomotives equipped with them in foreign countries.

It will be seen that the application of a feed water heater to a locomotive results in three principal advantages. First, it reduces the amount of coal required to produce the required amount of power; second, it increases the available water supply and, third, it reduces the amount of back pressure on the pistons, making the locomotive easier in action and more powerful. These are all very real and practical gains which all traveling engineers can fully endorse.

When coal costs from $40.00 up to possibly $125.00 for each tender load, a saving of about 15 per cent represents a very substantial amount of money. In most cases feed water heaters are applied chiefly for this reason. In addition to the saving in the cost of the coal consumed, there is also the reduction in the quantity of company coal to be hauled and handled, which in severe weather or periods of heavy traffic, is an item of some importance.

Occasionally it happens, especially on very heavy passenger power, that the gain in quantity of water available is of equal or greater value than the reduction in fuel consumption. No one ever heard an engineer or despatcher admit that the tender of an engine carried too much water. A feed water heater by condensing exhaust steam and returning it to the tender, saves about 1,500 gallons in 10,000 gallons, without increasing its size or weight. It sometimes costs a surprising amount of money to make an unnecesary stop with a heavy train and the advantage offered by the heater in this direction is not to be overlooked.

Tests

There have been a large number of service tests made with feed water heaters during the past few years. These have covered both passenger and freight service on both mountainous and level districts, and in general all show practically the same results. The following are some typical examples of the results of such tests:

	With Heater	Without Heater	%	With Heater	Without Heater	%	With Heater	Without Heater	%
Type locomotive..	4-6-2	4-6-2	...	2-8-0	2-8-0	...	2-8-2	2-8-2	...
Class service.....	Pass	Pass	...	Fr't	Fr't	..	Fr't	Fr't	...
Tonnage train .	481	506.5	5	2,759	2,724	1.3	3,251	3,224	8
Running time	3-23	3-23	...	6-8	6-13	...	5-12	5-35	6.5
Av. steam pressure.	201.6	202	...	203.5	203	...	173	172.5	...
Total fuel—lbs ..	9,617	11,00[illegible]	12.6	22,641	26,370	14.1	18,393	21,640	15
Water evaporated per pounds fuel burned	7.82	6.75	13.7	7.2	6	20	7.807	6.698	16.55

A year or so ago one railroad made a very careful investigation to determine the exact gain made by the reduction in back pressure on the pistons by the application of feed water heaters. A series of comparative runs were made where conditions of speed, cut-off and steam pressure were exactly the same at certain points on the road. Indicator cards were taken at these points, and a comparison developed the fact that 3¼ per cent less steam was required to give a unit of work with the heater than when using the live steam injector at a speed of 10 miles an hour, and over 6 per cent at from 35 to 43 miles an hour. This was all due to the reduction in back pressure caused by the condensing action of the heater.

Another more crude but no less convincing example of the same effect occurred on some comparative runs with and without heaters in use on a heavy passenger locomotive. On one portion of the run there was a very heavy grade about 15 miles long. It was found that when the heater was used, the same weight train could be taken up this grade in from two to three minutes less time.

These three chief advantages of a feed water heater on a locomotive are no longer a subject for debate or discussion. There are now well over a thousand feed water heaters in service in this country, and many road or service tests made under all possible conditions have proved them beyond question. Many, or possibly most of you, have had personal experience with heaters and have made experiments of your own. If these trials were fair to yourself and the device, they have convinced you of these facts.

At this point the committee would like to offer a word of advice or warning. In all tests of a feed water heater it should be remembered that it is chiefly a boiler appliance. The real comparison to show its effect is that of amount of water evaporated for each pound of coal burned. This comparison will of course cover a period of time, be carried through the cycle and appear truly in the amount of coal consumed per thousand gross ton miles. However, you all realize the rather wide variation that always exists in the amount of steam used to haul the same tonnage on any individual trips, because of variable operating conditions, weather, etc., also the great difference in the train resistance of the same tonnage, and must recognize that the coal consumption on a ton mile basis will vary through quite wide limits without any alteration to the locomotive equipment. Therefore, do not reach an inaccurate conclusion of the effect of a feed water heater by counting the scoops of coal on a trip or so, unless you are positive that all conditions are truly comparative. It is far safer to arrange for a measurement of the water used and base your conclusions on the ratio of water to coal. While, of course, even this comparison does not include the effect of the reduced back pressure mentioned above, nevertheless it will be sufficiently close for all practical purposes. If the exact facts are required, a dynamometer test will be necessary.

Boiler Checks

When a pump is used to feed a boiler, the check valve will come to its seat at each stroke of the pump, unless a very large air chamber is used. Because of the size and weight restrictions, high speed pumps are used on locomotive feed water heaters, and there has been some trouble reported when the same boiler check was used as with an injector. This trouble was chiefly due to the small size and high lift of the check, which allowed a very hard hammer against the seat at each pump stroke, which has resulted in the valves leaking and broken valves were often found. An enlargement of the size of the valve permitting a very small lift has eliminated this trouble to a large extent. It has been found entirely satisfactory to employ lifts of 1/8 to 3/16 inch on valves 2 1/2 inches in diameter. While these valves seat at each stroke of the pump, the low lift prevents damage to the seat or valve.

Experiments are under way with a number of specially designed check valves, with the idea of still further improving the situation. Understand spring check valves are now being used with good results, but as these have only been in service a short time cannot say as to their durability.

Effect of Bad Water

Waters containing sufficient impurities to require frequent washing of the locomotive boiler will also affect the feed water heaters. In the case of the closed type heater, deposits from bad waters are found in the heater, principally in the tubes of the third and fourth passes. The deposit on the heater tubes is far less than on the boiler tubes, and is easily removed in less time than it requires to wash the boiler.

In the open type heaters the scale is found throughout the heater, and if allowed to accumulate will affect the proper action of the bucket float. It is also deposited in the cylinder and around the valves of the hot water section of the pump, where it may interfere with the proper action of the pump.

In the closed heater the scale is removed by a weak solution of muriatic acid (four parts water to one part acid) rapidly circulated through the tubes by a small pump. This is followed by a circulation of water to remove all traces of the acid. Use of the acid solution has not been found injurious to the heaters.

The cleaning operation is required about every second or third boiler wash for the best results. If allowed to run longer than this, it will have no effect on the operation of the equipment, but the efficiency will be seriously decreased. The washing solution can be used over again a number of times, and only requires the addition of the amount wasted. The cleaning operation seldom requires over 30 minutes, and often 15 minutes is sufficient.

Cleaning is not required so often on the open type heater. In this case the scale is dissolved by full strength acid allowed to stand for sometime, or the parts are removed and cleaned by acid or scraping.

Effect on Superheat

When a feed water heater is applied to an existing locomotive, it brings about a condition where there is about 15 per cent less hot gas passing over the superheater units while there is no reduction in the amount of steam passing through them. This results in a somewhat lower temperature to the steam leaving the superheater. Trials covering a wide range of conditions show that the drop in superheat averages about 25 degrees. This means that somewhat less than 2 per cent more steam will be required for a unit of power in the cylinders.

However, as shown above, the decrease in amount of steam per unit of power caused by the reduced back pressure, is from 3 per cent to over 6 per cent, which more than counterbalances the loss from drop in superheat. Of course, it is easily possible to offset this drop in superheat. On new engines this is generally arranged and the full gain from reduced back pressure is obtained.

Service

No matter how successful a device may be in theory or on test, it will very quickly lose a part of its value if it requires undue attention at the terminals or makes it necessary to delay a locomotive either at terminals or on the road. It is on this rock that many apparently valuable devices have been wrecked.

Feed water heaters have been in service under our conditions for over six years in a few cases, and in considerable numbers for over two years. It is possible now to determine with some accuracy what can be expected from these designs as regards reliability, durability and cost of maintenance.

As regards reliability, the three types of heaters are giving a very satisfactory performance. The failures of the closed type of heater in service on which we have received information have been due to the breakage of some part or to the clogging of the tank hose strainer. In some of the earlier designs trouble was also caused by leakage at the tube joints, pipe joints leaking caused by vibration, broken piston rods, etc. In the open type heater some trouble has been encountered in starting, due to the sticking of the main steam valves of the pump, and also in getting the pump to handle the hot water when there is not a sufficient back pressure available to force it into the pump cylinder. There have also been some cases reported where, due to failure of the internal float to operate properly, the heater was filled with water, which passed the check valve provided in the exhaust steam pipes and entered the cylinders.

All of these failures, however, have been the exception and have been largely overcome by the manufacturers. The exhaust steam injector has not yet been in service in this country a sufficient length of time to determine definitely what may be expected in the way of maintenance. However, five of them have been in operation on one road for about one and a half years and the only thing that has developed is a slight wearing of the tubes, which is common with all injectors, and the necessity for frequent cleaning of the check valve in the oil separator. The injector tubes are easily removed and the work of applying new tubes is not any more difficult than with live steam injectors. As these equipments now stand, there need be no hesitation in applying them on the basis of reliability.

Practically the same situation exists as regards durability. Such parts as have shown weakness or unusual wear, have been improved by the manufacturers, and experience with the later designs indicates that they should easily go between shoppings without more attention than renewal of rod packing, filter cloth, or an occasional gasket.

From the above remarks it will be clear that the committee believes the feed water heaters have now been proven to have reached a satisfactory stage as regards their dependability, and this, of course, is only another way of stating that the maintenance is low.

Conclusion

The fact that over one-third of the new locomotives ordered between March 1, 1922, and May 1, 1923, were equipped with feed water heaters, and the further fact that in addition to these a number of railroads have entered upon the program of applying feed water heaters to locomotives as they pass through the shop, clearly indicates the standing that this appliance has attained in the minds of those who have had the longest experience with it. The roads on which the largest number of feed water heater equipments are being applied or are now in use are those which have had two to four years' experience with equipments in service.

When it is further considered that the equipments to be obtained today have the improvements incorporated in them that the service of the earlier examples developed, it is the recommendation of this committee that the members proceed to obtain exact data and facts from railroads now having feed water heaters in service in considerable numbers, whose operating conditions may be similar to that of the investigators, with the idea of extending the use of the feed water heater as an economic device.

The committee that presented the report consisted of Messrs. A. M. Boyd, chairman, H. M. Sefton, William Grady, F. A. Callan and W. A. Buckbee.

Stockholders in American Railroads

There were 777,132 railroad stockholders of the Class I railroads on December 21, 1922, the latest date for which complete figures are available, according to a special report of the Interstate Commerce Commission. This was an increase of 24,165 stockholders compared with the same date in 1921.

The total as of December 21, 1922, showed that there were 348,575 in the Eastern district, 74,699 in the Southern district and 353,858 in the Western district.

The report further shows that during the year $527,726,543 par value of new railroad securities were issued. Of this amount $65,400,734, or only 14 per cent, was in stock, and the remainder, $462,325,709 in bonds or other funded obligations.

The net increased investment in road and equipment during the year is shown as $302,106,786. Expenditures for new lines and extensions, $48,551,339, and expenditures for additions and betterments to $418,870,780, while property retired or written off amounted to $140,205,192 and various adjustments to $25,110,141.

Air Service in Mexico

A contract providing for passenger and freight service by airplane has been signed by the Minister of War with the representative of the Aerial Navigation Co. of Mexico. This company is allied with the Aerial Navigation Co. of Colombia, which has been operating a mail and passenger service between Cartagena and Bogota for the past two years.

Notes on Domestic Railroads

Locomotives

The New York Central R. R. Co. has ordered 20 locomotive tenders from the American Locomotive Company and also 15 from the Lima Locomotive Works. These tenders will have six-wheel trucks and a capacity of 15,000 gal.

The Savannah & Atlanta Railway is reported to have placed an order for one Mikado type locomotive with Baldwin Locomotive Works.

The Greenbrier & Eastern R. R. Co. has ordered one Mikado type locomotive from the Baldwin Locomotive Works.

The Oconto Company has placed an order for one 30-ton shay locomotive with the Lima Works.

The Lakeside & Marblehead R. R. is reported to have purchased one switching locomotive from the Lima Locomotive Works.

The Norwood & St. Lawrence R. R. Co. has ordered one Mogul type locomotive of 125 tons from the American Locomotive Company.

The Mesabi Iron Co. is reported to have purchased one switching locomotive from the American Locomotive Company.

The Richmond & Fredericksburg & Potomac R. R. is reported to have purchased two Pacific type locomotives from the Baldwin Locomotive Works, and two Mountain type locomotives from the American Locomotive Company.

The Pacific Lumber Company has ordered one Mikado type locomotive from the Baldwin Locomotive Works.

The A. S. Johnson Lumber Co., Reader, Ark., will soon be in the market for three oil burning locomotives.

The Victorian Government Railway of Australia has issued an inquiry through the department of trade and commerce of Ottawa, Canada, for ten Mountain type and ten Pacific type locomotives.

The Missouri Pacific R. R. is reported to be considering the purchase of additional motive power.

The Lake Champlain & Moriah R. R. Co. is inquiring for one locomotive.

Caminhas de Ferro de Lourenco Marques, Portuguese, East Africa, has ordered 2 Pacific type locomotives from the Baldwin Locomotive Works.

Freight Cars

The Elgin Joliet & Eastern Ry. has ordered 500 steel underframes from J. G. Heggie & Sons, Joliet, Ill.

The Central Railroad of Brazil is inquiring through the car builders for 100 gondola cars.

The Minnesota Steel Company has ordered 44 hopper cars from the Pressed Steel Car Company.

The New York Central R. R. is reported to be in the market for 100 automatic dump cars.

The Union Pacific System is inquiring for 25 caboose cars.

The Chicago Burlington & Quincy R. R. is reported to have awarded a contract for repairs to a number of miscellaneous freight cars to the Pullman Company.

The New York, Ontario & Western Railway has placed an order for 16 steel underframes with superstructures for caboose cars, with the Pressed Steel Car Company. The cars to be built in railroad company shop at Middletown, N. Y.

The Toledo, Peoria & Western Ry. is reported to be in the market for repairs to 27 box cars.

The Universal Portland Cement Company is inquiring for 50 hopper cars of 70 tons capacity.

The Atchison Topeka & Santa Fe has ordered 300 mill end gondola cars and 200 flat cars from the Pullman Company.

The Baltimore & Ohio R. R. is reported to be in the market for repairs to 200 coke cars.

The Havana Central is inquiring for 25 steel underframes for cane cars of 15 tons capacity.

Mitsui & Company, New York City, are reported to be in the market for 60 box cars of 30 tons capacity.

The New York Central R. R. Co. has ordered 500 hopper car bodies of 55 tons capacity from the Merchant Dispatch Transportation Company.

The Montour Railroad has ordered 500 cars of 55 tons capacity from the Standard Steel Car Company.

The Central of New Jersey R. R. has arranged for repair of 600 cars as follows: 200 with the American Car & Foundry Company, 200 with the Pressed Steel Car Company and 200 with the Standard Steel Car Company.

The Texas Company is inquiring for 10 tank cars of 6000 gal. capacity.

The Bradford Oil Refining Co. has purchased 5 tank cars from the General American Tank Car Corporation.

The Jonesboro Lake City & Eastern R. R. Co. is rebuilding box cars in its own shops.

Swift & Company has ordered 100 steel under frames for refrigerator cars from Bettendorf Company.

The Union Pacific R. R. has ordered 200 tank cars of 12,500 gal. capacity from the Standard Tank Car Company.

The Cuba Cane Sugar Corporation has ordered 35 cane cars of 30 tons capacity from the American Car & Foundry Company, and 25 cane cars of 15 tons capacity from the Koppel Car & Equipment Company.

The Denver & Rio Grande Western R. R. is inquiring for 50 narrow gauge refrigerator cars of 25 tons capacity.

Arthur G. McKee & Co., Cleveland, Ohio, is inquiring for 12 ore cars of 75 tons capacity.

Passenger Cars

The Wabash Railway Co. has ordered one steel private car from the American Car & Foundry Company.

The Toronto Hamilton & Buffalo Railway Co. is inquiring for ten coaches, six smoking cars and six baggage cars.

The Mexican National Railway has placed an order for 5 coaches with the Pullman Company.

The Central Vermont has ordered 2 steel 55 ft. combination passenger smoking and baggage storage battery cars, from the Railway Storage Battery Car Company, New York, N. Y.

The Chesapeake & Ohio Ry. Co. is inquiring for 6 combination mail and express cars 70 ft. long.

The Gulf Coast Lines are inquiring for four passenger coaches, two baggage cars, two baggage and mail cars, and one cafe observation car.

The Erie R. R. Co. has placed an order for 44 steel suburban coaches with the Pressed Steel Car Company.

Burr & Company is inquiring for one dynamometer car.

The Havana Central has ordered 3 Mack gasoline rail motor cars for use on the United Railways of Havana from the International Motor Company.

The Union of South Africa is inquiring for 25 first class and 25 second class narrow gauge coaches.

The Philadelphia & Reading Ry. is inquiring for 40 steel suburban coaches and 10 steel suburban combination coach and baggage cars.

The Central of New Jersey R. R. is inquiring for 50 coaches, 10 baggage cars and 5 combination passenger and baggage cars.

Buildings and Structures

The Wabash Railway is reported to have plans under way for the construction of a reinforced concrete and brick car repair shop at Decatur, Ill.

The Pennsylvania Railroad is planning the erection of additional buildings in connection with its new car repair shops at Enola, Pa.

The Kansas City Southern Railway is reported to have plans for the construction of a car repair shop at Shreveport, La., to replace the one destroyed by fire.

The Pennsylvania Railroad will remodel and equip the freight car shop at Altoona, Pa., for a new engine house.

The Wabash Railway has awarded a contract to Townsend B. Smith of Decatur, Ill., for the erection of an additional building to its locomotive repair shops at Decatur, Ill.

The Missouri Pacific R. R. is planning the removal of its engine headquarters from Hoxie, Ark., to Poplar Bluff, Mo. Plans are under the way for enlargements of shop and roundhouse facilities at Poplar Bluff, Mo.

The Chesapeake & Ohio Ry. Co. will construct a new engine house and additional tracks in its yard at Russell, Ky.

The Southern Railway is said to be preparing plans for the erection of a new shop and freight yards at Caswell, Tenn.

The Alabama & Vicksburg Ry. has awarded a contract to the Truscon Steel Company, Youngstown, Ohio, for the erection of a repair shop at Vicksburg, Miss., to cost approximately $57,000.

The Southern Pacific Co. has prepared plans for the construction of a one-story machine shop at Los Angeles, Calif.

Chicago & Eastern Ill. Ry. contemplates the construction of a freight yard at Terre Haute, Ind., in connection with the new locomotive and car shops at this place.

The New York, Chicago & St. Louis R. R. Co. closed bids lately for the construction of a new roundhouse at West Frankfort, Ind.

The Missouri Pacific R. R. Co. closed bids lately for the remodeling of a roundhouse at Kansas City, Mo.

Items of Personal Interest

W. W. Leman, superintendent of motive power of the Denver & Rio Grande Western R. R. with headquarters at Denver, Colo., has resigned and the office of superintendent of motive power has been abolished.

W. J. O'Neill, superintendent of motive power of the Second district of the Chicago, Rock Island & Pacific, with headquarters at El Reno, Okla., has been appointed general mechanical superintendent of the Denver & Rio Grande Western R. R. with headquarters at Denver, Colo.

J. W. Highleyman, superintendent of shops of the Union Pacific R. R., with headquarters at Cheyenne, Wyo., has been promoted to assistant superintendent of motive power with headquarters at Omaha, Neb.

Walter A. Deems, master mechanic of the Baltimore & Ohio R. R., New York Terminal Lines and the Staten Island Rapid Transit Company with headquarters at Tompkinsville, Staten Island, New York has resigned.

William G. Knight has been appointed mechanical superintendent of the Bangor & Aroostook R. R. Co. succeeding Laird W. Hendricks, deceased.

John Love has been appointed assistant master mechanic of the Lehigh & Susquehanna division of the Central R. R. of New Jersey with headquarters at Mauch Chunk, Pa., to succeed C. W. Culver.

B. H. Davis has been appointed master mechanic of the Lehigh & Susquehanna division of the Central R. R. of New Jersey with headquarters at Ashley, Pa., succeeding A. B. Enbody, deceased.

Arthur S. Stewart has been promoted from the position of round house foreman of the Southern at Charleston, S. C., to that of general round house foreman at Meridian, Miss.

H. C. Caswell has been appointed master mechanic of the Delaware, Lackawanna & Western R. R. Co., with headquatrers at Binghamton, N. Y.

S. H. Bray, formerly fuel inspector in the Fuel Bureau of the Southern Pacific has been promoted to road foreman of Engines, San Joaquin Division. His position as fuel inspector at San Francisco, Calif., has been taken by L. A. Hamlin, formerly assistant road foreman of Engine of the Coast Division.

C. W. Culver has been appointed works manager in charge of the locomotive and car shops of the Central R. R. of New Jersey with headquarters at Elizabethport, N. J.

Charles Pinkston Keever, formerly assistant roundhouse foreman of the Southern Railway with headquarters at Spencer, N. C., has been promoted to machine and erecting shop foreman with headquarters at Charleston, S. C.

J. D. Young of the Central R. R. of New Jersey has been appointed mechanic of the Lehigh & Susquehanna division in charge of locomotive and car department with headquarters at Ashley, Pa.

M. R. Brockman, formerly general foreman of the mechanical department of the Southern Railway at Greenville, S. C., has been promoted to general foreman at Asheville, N. C., to succeed J. L. Cantwell, promoted.

J. E. O'Brien, manager of the Mechanical Department of the Seaboard Air Line, will hereafter have the title of Chief of Motive Power and Equipment, the former title being abolished.

Frank M. Fair, formerly assistant foreman of Coster Shops, Southern Railway at Knoxville, Tenn., has been promoted to foreman boiler maker, to succeed Ernest Keathley, resigned to accept service elsewhere.

R. C. Young has retired as boiler shop foreman on the Chicago & Northwestern with headquarters at Baraboo, Wis., and is placed on the pension list, after being with the company almost forty years.

P. Campbell has been promoted to superintendent of motive power of the Chicago Junction Railway with headquarters at Chicago, Ill., to succeed James Fitzmorris made general manager.

A. W. Sharp has been promoted to master mechanic of the Uintah Railway with headquarters at Atchee, Colo., to succeed R. W. Burnett, resigned.

Supply Trade Notes

Alfred A. Corey, Jr., was elected president of the **Vanadium Corporation of America** at last meeting to succeed **J. Leonard Replogle** who resigned recently on account of ill health.

The American Locomotive Company has announced that **W. E. Corrigan** has been appointed on the Pacific coast under the title District Sales Manager. Mr. Corrigan's headquarters will be at Rialto building, San Francisco, Calif. Mr. Corrigan has been with the American Locomotive Company since 1909.

The McNyler Interstate Co., Cleveland, builder of locomotive cranes, and other conveying equipment has moved its New York City offices from Hudson Terminal Building to Woolworth Building. **George E. Titcomb**, eastern branch sales manager, is in charge.

E. I. Du Pont de Nemours & Company, Fabrikoid division, Newburg, New York, has appointed **Ross S. Hayes**, 2 Rector St., New York City, as eastern sales agent, railway division, for sale of its Fabrikoid products. Mr. Hayes' territory includes New England, southern and middle Atlantic States.

Dr. Thomas Addison has retired at his own request as Pacific coast manager of the **General Electric Co.**, and will be succeeded by **J. A. Cranston**, formerly northwestern manager. Dr. Addison has been with General Electric for a period of thirty-three years.

Consolidated Machine Tool Corporation of America, Rochester, New York, has elected **Henry J. Bailey** president to succeed W. H. Marshall who died August 23.

The Truscon Steel Company is preparing plans for a new plant at Pittsburgh, Calif.

General Electric Company has appointed **John F. Cunningham, Jr.**, assistant manager of production department of the Schenectady Works, Schenectady, New York.

Whiting Railway Motor Car Co., Tampa, Fla., plan the immediate establishment there of a large plant that will be devoted to the mnufacture of gasoline propelled passenger cars for the railroad service.

The Train Control Corporation of America has been organized with headquarters at 1409 Grand Central Terminal, New York City. **F. B. Lincoln** is president and general manager, **Col. H. B. Hunt**, director supervising manufacturing and air brake engineering, **George Sergeant, Jr.**, director supervising contracts and installation and **Bruce J. Delette** is secretary and treasurer. The corporation has taken over the Clifford Automatic Train Stop Company, proprietor of the Clifford Automatic Train Stop.

W. M. Bostworth has resigned as mechanical engineer of the **Wine Railway Appliance Company**, Toledo, Ohio, and is now affiliated with the **Metal Fibre Rope Company**, Toledo, Ohio, as vice-president.

The Superheater Company is preparing plans of an addition to its plant at East Chicago, Ind., to cost approximately $75,000.

C. F. McCuen, representative of the **W. H. Miner Company**, Chicago, Ills., has been appointed general sales agent of the **Camel Company**, Chicago, Ills.

Walter A. Deems has been appointed representative of the machine tool department New York district of **Manning, Maxwell & Moore, Inc.**, with headquarters at 100 East Forty-second St., New York City. Mr. Deems was formerly master mechanic of the Baltimore & Ohio's New York Terminals and the Staten Island Rapid Transit Company.

The Consolidated Car-Heating Company, Albany, New York, has secured the patents, equipments, good-will and other assets of the Automatic Ventilator Company of New York City.

The Prime Manufacturing Co., Milwaukee, Wis., is preparing plans for erection of a modern brass foundry of approximately 18,000 sq. ft.

Exum M. Haas has resigned as manager of the railroad department of the **H. K. Ferguson Company**, Cleveland, Ohio, to open an office as consulting engineer at 2075 Taylor Road, Cleveland, Ohio. Mr. Haas will retain connection with the H. K. Ferguson Company as consulting engineer on railroad projects and will specialize in railroad shop and terminal planning.

Truscon Steel Company, Detroit, Mich., will be located in its new building at 615 Wayne street, Detroit, Mich. The office includes a complete service organization and engineering department.

J. D. Phillips has been appointed office manager of the **General Electric Company's** new plant at Oakland, Calif. Mr. Phillips was formerly traveling auditor.

S. G. Eastman, western sales manager of the **Niles-Bement-Pond Company**, with headquarters at San Francisco, Calif., has been transferred to Chicago, Ill., to succeed G. F. Mills, Chicago, sales manager, retired.

The Stafford Roller Bearing Car Truck Corporation, Lawton, Mich., manufacturers of the Stafford Roller bearings for cars, is building an additional plant at Ludington, Mich. This new structure gives the company an increased manufacturing capacity which is made necessary by the growing demand on the part of the railroads for these bearings.

The Rice Manufacturing Co., Indianapolis, Ind., manufacturers of the "Red Devil" rivet cutter, have appointed **Henry C. Ashmead**, Brown Marx Building, Birmingham, Ala., as their sales representative for the Southern territory.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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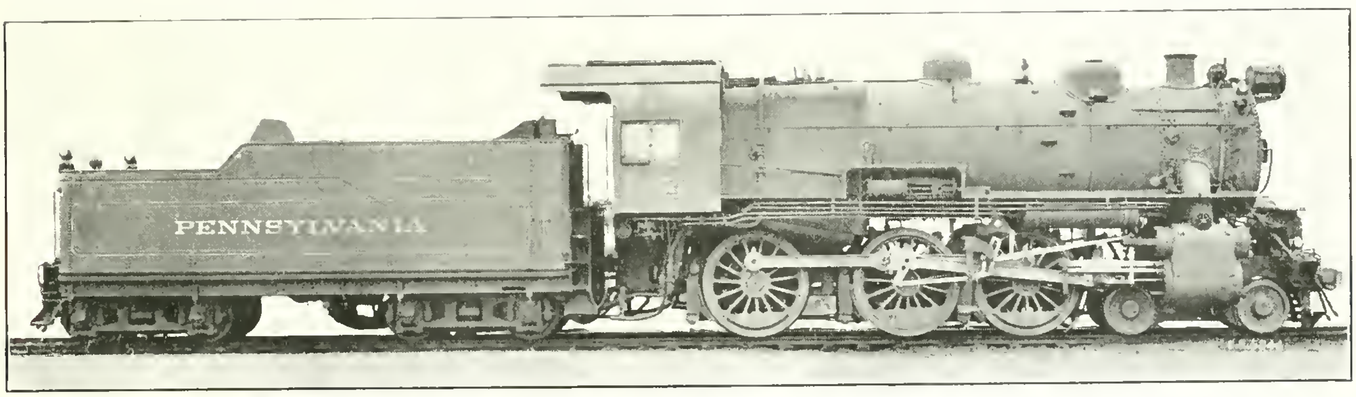
Ten-Wheeled Passenger Locomotive for Pennsylvania R. R.

A New Design Intended for Local Service

The Pennsylvania Railroad has had a new design of ten-wheeled (4-6-0) passenger locomotive in service on local passenger trains for several months. The locomotive was designed to meet the requirements of a local passenger traffic where the grades frequently require double heading if one of the smaller Atlantic or American type locomotives are used. Such service ordinarily requires that there shall be a high tractive effort in order to insure quick starting and rapid acceleration. It is a case where tractive effort is of more importance than the ability to run at high speed. It was because of the need for an engine of this type that the engines under consideration were designed.



New Ten-Wheeled Locomotive, Class G5S of the Pennsylvania Railroad

Some of these locomotives are now hauling heavy trains over steep grades on very exacting schedules, and the results obtained in service amply justify the design.

The general appearance of the engine is shown by the outline of the side elevation and the half-tone reproduction of the photograph.

A tractive effort of 41,328 lbs. is obtained with 68 in. driving wheels carrying a weight of 178,000 lbs. giving a tractive ratio of 4.3.

It is of the regular Pennsylvania design and would be recognized as such anywhere. In its details it follows the standard practice of the road. The weight on the individual drivers is not so high as has been on some of the former designs, but with a weight of more than 29,660 lbs. on each wheel it has a total above that of the heavy Atlantic of the E6S class, which were built about 1914 and had a weight of 34,000 lbs. on each driver or a total of 136,000 lbs. The tractive effort of the G5S class locomotive is 3,132 lbs., less than the K4S class Pacific whose total engine weight is 308,890 lbs. as against 237,000 lbs. of this ten-wheeler. This design, therefore, has practically 93% of the tractive effort of the heavy Pacific with about 77% of the total weight.

Such figures as these would, of themselves, be a complete justification of the design.

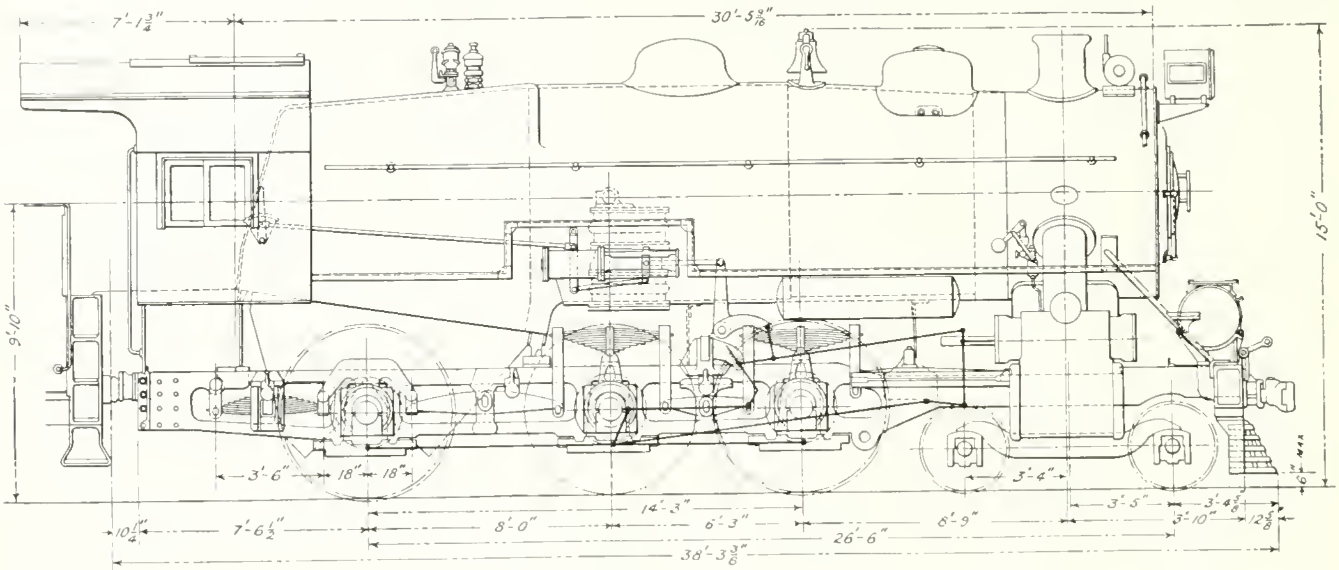
In accordance with Pennsylvania practice the boiler is of the Belpaire wide firebox type. The internal diameter is 70¾ in. at the front end, and 81¾ in. at the dome. This has made it possible to use 242 tubes 2 in. in diameter and 36 superheater flues of 5½ in. diameter, all of which are but 15 ft. long between the tube sheets.

The firebox is 110¼ in. long by 72 in. wide, and has a grate area of 55.13 sq. ft. The back head is sloping and there is no combustion chamber. It is fitted with a security brick arch supported on three water tubes 3 in. in diameter. The grate is arranged with a slope of 17.8 per cent. down towards the front.

An exceedingly interesting feature in the construction of the boiler is the avoidance of the seam between the throat sheet and the lower half of the shell course. This is accomplished by flanging the course down so as to make what is usually a two-piece construction, in one piece. This involves a heavy piece of flanging work that is not usually done but which the Pennsylvania shops are equipped to do.

The plates of the shell are ⅞ in. thick and the horizontal seams are laid up with a double welt sextuple riveted.

A type "A" superheater, of 36 units is used. It has a heating surface of 798 sq. ft. The front end is of the self-cleaning type with an inside extension to the smokestack, which reaches 2⅞ in. below the center line of the boiler insuring a proper draft through all of the tubes. This extension is 17 in. inside diameter, which is that of the choke at the bottom of the outside stack, and is a straight cylinder with no flare. It are very short and straight. The heads of the steam chest have inwardly projecting bosses which leave a clearance for the movement of the valve. These are bushed at the inner end with brass bushings 4 in. long which serve as bearings to support the valve



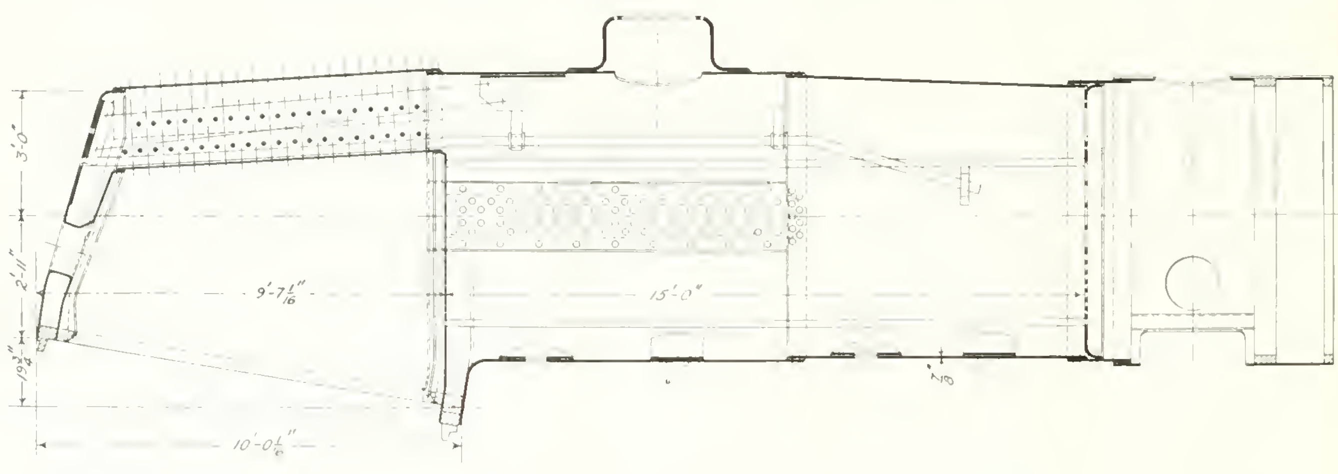
Outline of Ten-Wheeled Locomotive of the Pennsylvania Railroad

stands close to the diaphragm at the back, the gap between the two being but 2½ in.

As will be seen from the outline elevation and view of the engine, the entire boiler, including the firebox is carried above the driving wheels, ample provision being made for clearance, after the engine has settled on its springs.

The frames are of cast steel 4 in. wide and reinforced to 7⅞ in. over the driving boxes. The driving axles have a 3 in. diameter hole drilled through the center stem, and which can be readily removed and renewed when worn. The collar at the outer end of these bushings forms the bottom of the stuffing boxes for the valve stem and serves as a bearing for the packing. The stem is lubricated through oil holes in the heads.

The piston is made with a rolled steel center having a cast iron bull ring, carrying the piston packing rings. The cylinder heads are made to conform to the shape of the piston and leave a minimum of clearance as shown by the dotted lines in the engrav-



Boiler for the Ten-Wheeled Passenger Locomotive of the Pennsylvania Railroad

to facilitate their heat treatment. The journals are 9¾ in. in diameter and 13 in. long.

The valve gear is of the Walschaerts type with all parts made as light as possible, consistent with the strength required. The piston valve is 12 in. in diameter, and its weight is carried on the stem and its extension. The arrangement of the valve, steam chest, cylinder and piston is clearly shown by the engraving of the longitudinal section. The steam chest bushings are applied from either end of the chest and the ports ing, lines which show the position of the piston at the two ends of its stroke.

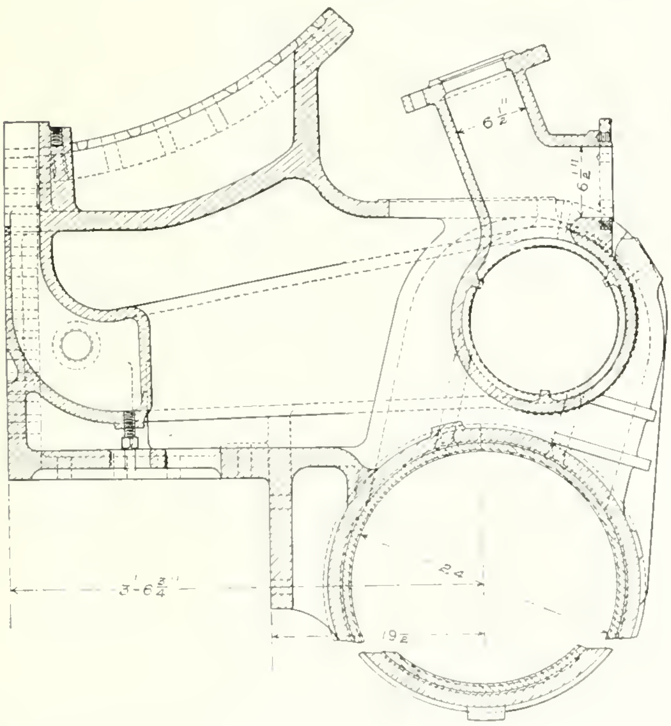
The piston rods are not of the extended type. They are hollow and conform to the practice followed on the Pennsylvania for a number of years. They are 4 in. in diameter and have a 2¼ in. hole drilled through the center. This hole is reduced to 1½ at the piston fit and to ¾ in. at the crosshead fit. An important feature in the design of the piston rod is that its length is such that the piston can be pulled out of the front end of the cylinder without cutting the piston rod loose from the crosshead.

The crosshead runs on three-bar guides and is of exceptionally light construction.

The main rods are of I section and $7\frac{1}{2}$ in. deep at the rear end and 7 in. at the front, with a $5\frac{1}{2}$-in. milled section of the rod maintained throughout the length. The flanges are $4\frac{1}{4}$ in. wide and taper from a thickness of $\frac{3}{4}$ in. at the front end to 1 in. at the back.

Special care has been exercised in designing the reciprocating parts in order to keep the weight as low as possible. The efforts in this direction have been very successful in that the weight of these parts for one side have been reduced to 1,008 lbs. or less than one-half of one per cent. (actually 0.425 per cent) of the weight of the locomotive. This gives a piston pressure of 92 lbs. per pound of reciprocating parts. This light weight of reciprocating parts and the consequent reduction in the weight of the counterbalance, enables the engine to maintain a speed of 70 miles per hour.

The throttle is of the floating stem type with a drifting attachment, a design which is exceptionally easy



Cross Section of Cylinder for Ten-Wheeled Locomotive of the Pennsylvania Railroad

to operate and responds instantly to any movement of the throttle lever in the cab. The details of the construction are clearly shown in the engraving. The main valve **A** is seated on a bushing set into the top of the standpipe and is keyed by the key **B** to a hollow cylindrical projection rising above the center of the balancing piston **C**. The central portion of the valve is bored out to receive the upper end of the throttle stem which has a limited amount of vertical motion therein and is provided with packing rings to prevent a steam leakage.

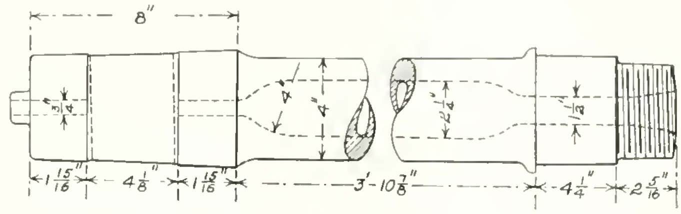
The stem has a slot cut in it to span the key **B** and allow for a certain amount of motion. The stem carries the pivot valve **D** which seats on the lower side of the throttle pipe. The engraving shows the throttle closed.

The first movement of the throttle lever lifts the pilot valve from its seat and admits steam to the under side of the balancing piston **C**.

The area and design of this piston is such that the excess of pressure on the main valve keeps the valve closed when the pilot valve is closed. Opening this pilot valve admits steam to the space below the packed end of the stem and flows out about the key to the dry pipe, serving to unseat the main valve.

The throttle valve is then nearly balanced and when the stem is raised so that the bottom of its slot as indicated by the dotted line, strikes the key, it can then easily lift the main valve. In closing the reverse process takes place.

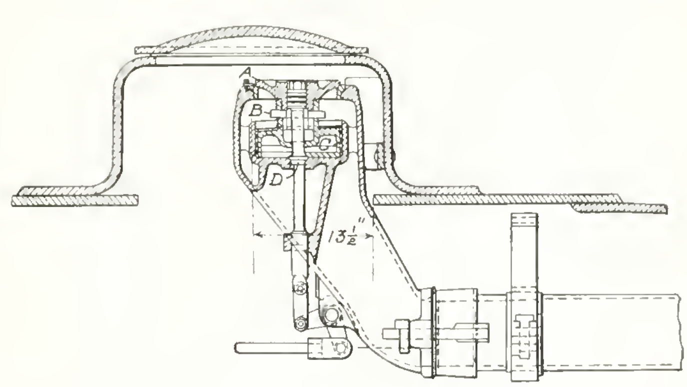
One of the striking features of the engine is the short cab that is used. This is made possible by the use of the air reversing gear, avoiding the necessity for a hand reverse lever with its long sweep. The air



Piston Rod for Ten-Wheeled Locomotive of the Pennsylvania Railroad

operated reverse gear has been made standard for this design of locomotive. It is provided with an auxiliary air reservoir and check valve which retains sufficient air for reversing the gear several times or holding it in place in case the main supply of air fails for any reason.

The cylinders are of the half saddle type and have outside steam pipes. Cast integral with the cylinder is the steam pipe connection with flange, the pipe being about 16 in. long and $6\frac{1}{2}$ in. inside diameter. This pipe stands practically free from the balance of the cylinder casting and is free to expand or contract with the varying temperatures to which it is exposed without being subjected to any undue restraining stresses. Considerable difficulty due to cracking has been experienced by other railroads with other designs of cylinders in which the steam passage is closely tied to the main body of the cylinder from cracking. The freedom to expand



Throttle Valve for Ten-Wheeled Locomotive of the Pennsylvania Railroad

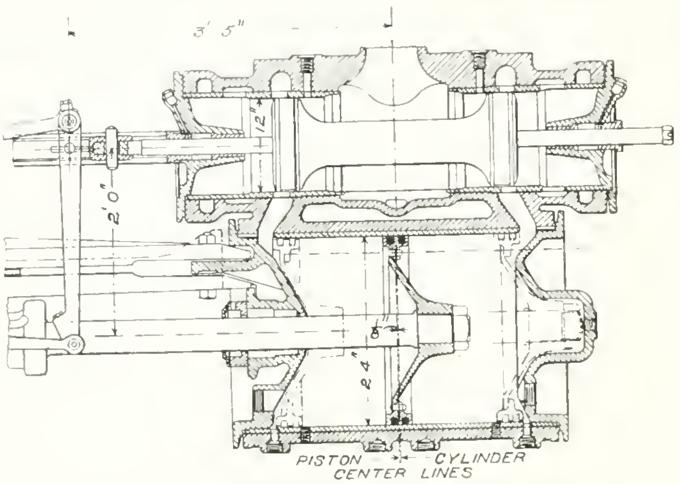
and contract which is afforded by this design will avoid this trouble.

These cylinders are provided with the usual Pennsylvania design of snifting valve.

The general dimensions of the locomotive are as follows:

Tractive Effort	41,328 lbs.
Weight in working order	237,000 lbs.
Weight on drivers	178,000 lbs.

Weight on leading truck	59,000 lbs.
Weight of Engine and Tender in working order	413,500 lbs.
Wheel base, driving	14 ft. 3 in.
Wheel base, total	26 ft. 6 in.
Wheel base, engine and tender	62 ft. 7¾ in.



Section of Steam Chest and Cylinder for Ten-Wheeled Locomotive of the Pennsylvania Railroad

RATIOS

Weight on drivers—tractive effort	4.3
Total weight—tractive effort total	5.7
Tractive effort x diameter drivers—total heating surface	766.
Firebox heating surface—total heating surface	5.05
Weight on drivers—total heating surface	48.6
Piston displacement, cu. ft.	14.66
Total heating surface—piston displacement	249.
Grate area—piston displacement	3.76
Piston pressure—weight of reciprocating parts	92

CYLINDERS

Diameter	24 in.
Stroke of Piston	28 in.

VALVES

Kind	Piston
Diameter	12 in.
Greatest travel	7 in.
Lap	1 5/16 in.

WHEELS

Driving, diameter over tires	68 in.
Driving thickness of tires	4 in.
Engine truck wheels, diameter	33 in.

BOILER

Style	Belpaire Wide Firebox
Working pressure	205 lbs.
Outside diameter of first ring	78½ in.
Firebox length	110¼ in.
Firebox width	72 in.
Firebox plates, thickness	⅝ in.
Firebox water space	5 in.
Tubes, number	242
Tubes, outside diameter	2 in.
Flues, number	36
Flues, outside diameter	5½ in.
Tubes, length (Between Sheets)	180 in.
Heating surface tubes and flues (External)	2677 sq. ft.
Heating surface firebox	185 sq. ft.
Superheating surface	798 sq. ft.
Heating surface total	3660 sq. ft.
Grate area	55.13 sq. ft.
Dome height above rail	14 ft. 11¾ in.
Center of boiler above rail	9 ft. 10 in.

TENDER

Tank	Water Bottom
Wheels, diameter	36 in.
Water capacity	7800 Gal.
Coal capacity	29,300 lbs.

Locomotive Boiler Explosion Report

A report has been issued by A. G. Pack, chief inspector, bureau of locomotive inspection, Interstate Commerce Commission, covering the explosion of a locomotive boiler which occurred on the New York, New Haven & Hartford R. R., near Walpole Heights, Mass., Aug. 19, 1923. The locomotive was the 10-wheel type, equipped with extended wagon top boiler having narrow radial stayed firebox. The force of the explosion tore the boiler from the frame and running gear, hurling it a distance of approximately 300 feet, where it struck the ground and rebounded, and came to rest about 350 feet ahead from the point of explosion. Examination of the boiler, after the accident, confirmed by the shop reports, showed that the firebox had had a number of patches applied. Daily inspection reports previous to the accident had specified leaks at various places. The investigation therefore appeared to center around the condition of the firebox. Chief Inspector Pack cites a number of daily and monthly locomotive inspection and repair reports, all of which show the condition of flues and firebox sheets "good—good," in the language of the report, "notwithstanding the defective condition of the firebox, as indicated by the repairs made and the defective conditions evidenced by the daily locomotive inspection reports from August 1 to 18, inclusive."

Continuing, the chief inspector's report says: "It certainly could not be said that a firebox patched to the extent, as the records show in May, 1922, and to the extent that was found at the investigation of this accident could be termed in good condition, nor is it at all likely that all firebox leaks which were reported during the month of August developed after the report of August 7 was made. While it is evident that this accident was primarily due to the failure of the crown sheet because of having been overheated due to low water, it is apparent that the violence of the explosion was increased by the failure of the autogenous-stays, and our investigation further made it apparent that the sworn reports covering the condition of this firebox prior to the accident do not represent the true condition."

New York Central Builds New Dining Cars

The New York Central has completed eight new steel dining cars at the West Albany Shop.

The interior of these dining cars is arranged so that there is a dining room 36 feet 4 inches long, seating 36 persons. On one side of the car are located six tables seating four persons each, while directly opposite are six tables seating two persons each.

At one end of the dining room are located the linen lockers, crew's lockers and steward's locker, also lavatory containing washstand. At opposite end separated by partition are two refrigerators, also a buffet for use of the steward. Directly adjoining this is located the pantry, with its numerous lockers, small refrigerators, dish and tray racks, etc.

Following are some of the general dimensions:

Length over buffers, 81 ft. 1¾ in.; length over end sills, 72 ft. 6 in.; distance between centers of trucks, 56 ft. 6 in.; width over side sills, 9 ft. 10 in.; width over all at eaves, 10 ft. ⅛ in.; height from top of rail to top of eaves, 14 ft. 2 in.; height from top of rail to lower edge of sheathing, 3 ft. 7⅝ in.; height from top of rail to top of floor, 4 ft. 6⅛ in.; height from top of rail to center of coupler, 2 ft. 10½ in.; height from under side of side sill to top of side plate, 7 ft. 6¾ in.; length of center sill web plates, 51 ft. 6 in.; length of top cover plate, 52 ft.; weight, 164,000 lbs.

Four-Cylinder 4-6-0 Type Locomotive of the Great Western Railway—England

Tractive Effort of 31,626 Lbs. Is Greater Than Any Other British Passenger Locomotive

The locomotive shown in our frontispiece illustration, the "Caerphilly Castle", is the first of a lot of ten being turned out at the Swindon Works of the Great Western Railway of England that are to be known as the "Castle" class and to which interest attaches in that it is claimed that they are the most powerful passenger locomotives in the British Isles, the claim being based on the fact that the tractive effort, namely 31,626 lb. at 85 per cent of the boiler pressure, is higher than that of any other passenger engine on British railways.

Engine 4073 possesses several new and important departures from the design of previous engines of the same type. The increased tractive effort has been effected by giving an additional inch to the cylinders, which are 16 in. in diameter, the piston stroke of 26 in. remaining as before, as do also the piston valve diameters (8 in.) and the port areas the dimensions of these being 25 in. x 1¼ in. for the admission and 25 in. x 3 in. for the exhaust. The valves are of the inside admission type, are connected by horizontal rocking arms, and driven by two sets of Walschaerts motion between the frames. Steam is conveyed to the outside cylinders by external pipes brought through the smokebox sides and directly connected to the steam chests, the inside cylinders being supplied through passages in the saddle.

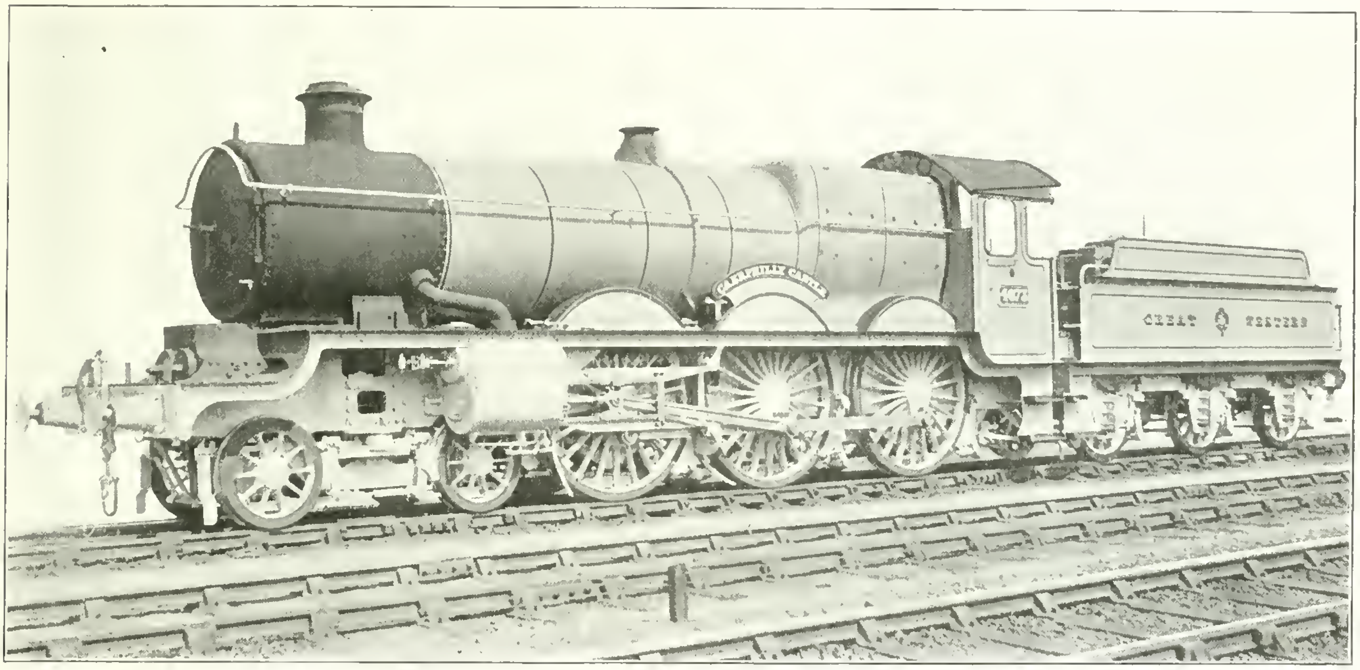


Diagram of Four-Cylinder 4-6-0 Type Passenger Locomotive, Great Western Railway of England

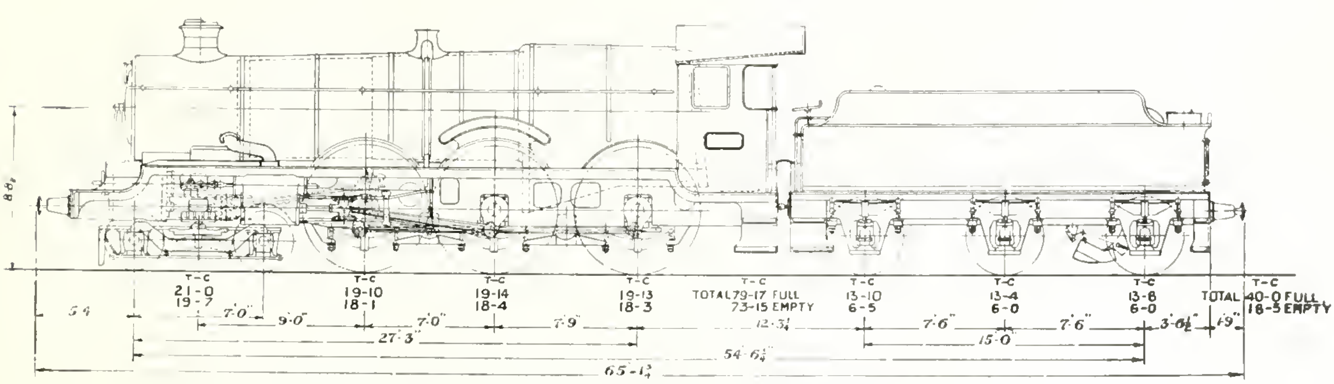
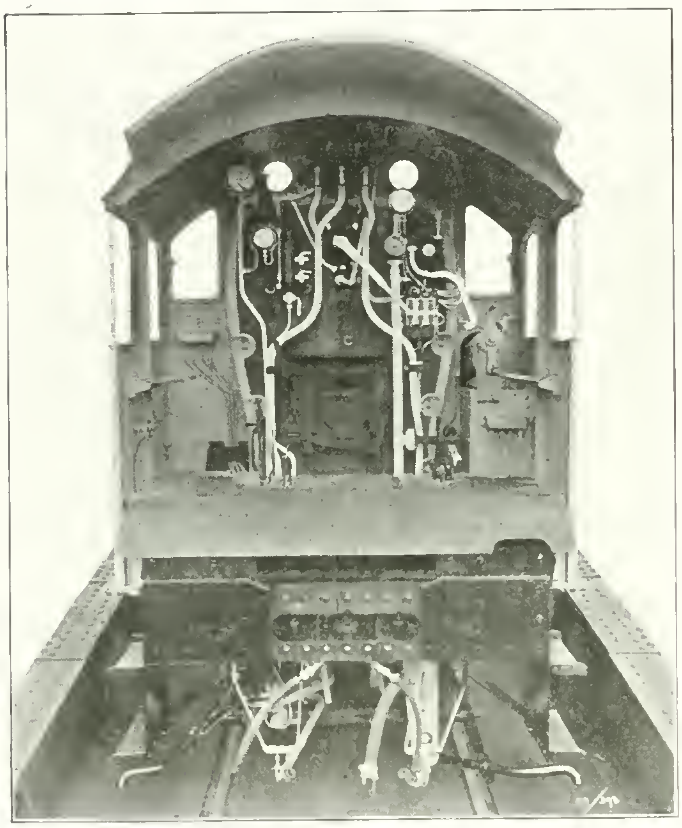


Diagram of Four-Cylinder 4-6-0 Type Passenger Locomotive, Great Western Railway, England

Commensurate with the larger cylinder volume, a new boiler has been designed of higher capacity than the preceding, though the special features of the Great Western Railway standard boilers are retained. The barrel has an outside diameter of 61 15/16 in. at the front end and 69 in. at the throat sheet, the length 14 ft. 10 in. There are 201 2-in. fire tubes and fourteen flues 5⅛ in. in diameter, of which the length is 15 ft. 2 7/16 in. and the tubes of the Swindon type superheater are eighty-four in number and 1 in. in diameter by 15 ft. 3⅜ in. long.

The grate area is 30.28 sq. ft. The working pressure is 225 lb.

The driving wheels are 80½ in. in diameter. While no change has been made in the disposition on total length of the wheel base, the overhang at the rear has been increased 1 ft., over previous practice. Advantage has been taken of the increased length of the



Interior of Cab of Great Western Railway Locomotive

frame to provide a longer cab than those at present existing. This, coupled with the fact that no fittings project into the cab beyond the regulator handle gives greatly increased space for the enginemen. The roof has also been considerably extended and the cab sides fitted with large windows, a further innovation being the provision of tip-up seats for the enginemen.

The engine is fitted with a copper top to the chimney, and brass safety valve cover. The cab and splasher beadings are also in brass and the hand rails are now polished. This is the first engine to be turned out since the War with lining, etc., as in pre-war days, and all engines of the 2900 and 4000 class will in future be lined as they pass through the shops.

The principal particulars of "Castle Class" locomotives are as follows:

Cylinders (four)—	
Diameter	16 in.
Piston stroke	26 in.
Steam ports	25 in. × 1¼ in.
Exhaust ports	25 in. × 3 in.
Wheels—	
Bogie, diameter	3 ft. 2 in.
Coupled, diameter	6 ft. 8½ in.
Boiler barrel—	
Length	14 ft. 10 in.
Diameter outside	5 ft. 9 in. and 5 ft. 1-5/16 in.
Firebox—	
Outside	10 ft. 0 in. × { 6 ft. 0 in. / 4 ft. 0 in. }
Inside	9 ft. 2-7/16 in. × { 5 ft. 0⅛ in. / 3 ft. 2⅝ in. }
Height	6 ft. 8⅞ in. × 5 ft. 3⅞ in.
Tubes—	
Super tubes, No. 84	Diam. 1 in., length 15 ft. 3⅜ in.
Fire Tubes, No. 201	Diam. 2 in. No. 14, diam. 5⅛ in., length 15 ft. 2-7/16 in.
Heating surface—	
Superheater tubes	262.62 sq. ft.
Fire tubes	1,885.62 sq. ft.
Firebox	163.76 sq. ft.
Total	2,312.0 sq. ft.
Grate area	30.28 sq. ft.

The tender is the standard six-wheel type of the Great Western Railway. It is equipped with a water scoop, and when full weighs 40 tons. It has a capacity of 6 tons of coal and 3,500 gallons of water.

The following comparison between the preceding type of four-cylinder engines and the "Castle" Class, as shown by certain ratios is of interest:

	"Abbey."	"Castle."
Total Cylinder Volume (piston displacement)	10.63 cu. ft.	12.10 cu. ft.
Factor of Adhesion	4.46	4.10
Evaporative Heating Surface ÷ Cylinder Volume	173.215	169.370
Firebox Heating Surface ÷ Grate Area	5.79	5.40
Total Heating Surface ÷ Grate Area	78.48	76.35

Reorganizing Austrian Railways

A law has recently been passed providing for the reorganization of the Austrian State Railways, for the purpose of placing them on a satisfactory economic basis. The law provides for the creation of a corporation in Vienna for the purpose of conducting the operations of the federal railroads. This corporation must administer the entire property of the railways and act as a trustee for the Government. The Government is to furnish a capital of 200 milliard crowns, and is to cover any deficits. Privileges regarding taxes and fees of the railways are accorded.

An executive committee of five members will be held responsible to a commission of 14 directors for actual operations. Eleven members of this commission are to be business men or experts in handling transportation problems, and are to be appointed by the Government for a term of three years. Three members are to be chosen by the railway employees. The executive committee is to be appointed by the commission and may be recalled by consent or order of the Government. The chairman of the committee will have the title of general manager and each of the other members that of manager.

In addition to managing operations the executive committee must pass on all reorganization questions, formulate operating policies and plans, appoint and manage the personnel, and submit a financial balance sheet monthly and annually. They may raise short term interior loans of low denominations. The commission of directors is charged with general supervision and with safeguarding the public interests.

The Government reserves the right to give or withhold approval of tariff changes and large or long term loans and will supervise social and safety measures and regulate construction and maintenance. The ministries of commerce and finance will receive the monthly and yearly balance sheets.

Economy in Running Locomotives Over Two or More Divisions

Committee Report to the Traveling Engineers' Association

The Traveling Engineers' Committee felt that the discussion on the subject of the advantage and economy of running locomotives over two or more divisions should be opened by referring briefly to past and present practices, and then taking up the matter of the advantages and economies, and, although the subject did not include it, the disadvantages of running locomotives over two or more divisions. The Committee in attempting to corral a maximum amount of information on this subject received answers to questionnaires from numerous roads and wishes to take this opportunity to express its appreciation to the various parties for their interest in this matter. The information gathered from the questionnaires will be referred to throughout the discussion.

By the term "Past Practices" the Committee refers to practices wherein locomotives were operated in both passenger and freight service over one operating division, the operating mileage varying with the length of the division. On some roads this practice is still in effect, on others the extension of locomotive runs to more than one division has been in effect only a short time, but other roads have been running their locomotives over more than one division for eight or ten years. As an example of what the Committee means by "Past Practices," on the New York Central Railroad passenger and through freight power on the main line was operated over one division of lengths varying from 100 miles to 180 miles until about two and one-half years ago. This example covers very satisfactorily the length of runs which were in vogue on many railroads throughout the country. One of the road's reports shows passenger runs varying between 144 and 187 miles, another from 101 to 175 miles, another 173 miles, another 161 miles. In freight operation we find the same variations, one road reporting from 70 to 144 miles, another from 100 to 147 miles, etc.

Under the term "Present Practice" the Committee refers to the mileage that is now being regularly operated in freight or passenger service, many roads reporting the extension of runs to more than one division, though it seems that the extension of runs in freight service has not gone as far as the extension in passenger service. The following table shows some examples of past and present practices as to the mileage operated.

MILEAGE OF LOCOMOTIVE RUNS IN PASSENGER SERVICE.

Roads	Past Practice	Present Practice	Increased Mileage
A	144—187	331	187—144
B	101—175	175	174—100
C	173	375	202
D	161	289	128
E	100—183	234—300	134—117
F	303	603	300

On the M. K. & T. runs of 678 miles, on the Union Pacific, 484 miles to 564 miles, and on the Burlington 483 miles, stand out as examples of high mileage which can be made per run with passenger locomotives. Sixteen roads reported substantial increases in the mileage per locomotive run, in most cases this increase amounting to double the former practice. The questionnaire was only sent to eighteen roads concerning which the practice of extending locomotive runs had been given more or less publicity.

Advantages and Economies in Longer Runs—Increased Mileage

One economy resulting from increasing the individual mileage per locomotive evolves into the increased mileage per locomotive over a period of time. While at many points it has been found possible to increase the mileage of individual runs by 100 per cent, due to the necessity of operation, it has not always resulted that the average miles per locomotive in the group considered would amount to 100 per cent, though the average mileage per locomotive per period of time has shown substantial increases ranging from 30 per cent to 100 per cent. The item of economy, which is of the greatest importance in connection with increased mileage per locomotive per period of time, lies in increased utilization of the power unit. Assuming the cost of general repairs as an investment of $10,000 and that this investment places the individual unit in condition to produce 100,000 miles, by making this unit produce the 100,000 miles in twelve months instead of eighteen months. The earnings on the $10,000 investment have been increased 33⅓ per cent. In other words, this economy is exemplified by what is known as a quick turnover of the money invested.

Decreased Number of Locomotives

Another item of economy closely parallel to the foregoing is the decreased number of locomotives necessary for the service. The reports from questionnaires indicated that this decrease in number of units extends all the way to 100 per cent; in other words, at several places the same service is being maintained with one-half the power which was formerly required. Naturally this will result in time and has already been felt in decreased purchases of new power. The positive examples of this economy are shown in answers to the questionnaires, one road reporting five engines now covering the service as against nine engines formerly; on another road two engines are used as against four engines; on another five engines are used as against six engines; on another 26 engines are used as against 52 engines; another shows 38 as against 40 engines; another shows six engines as against 11 engines, while another shows 47 as against 54 engines, and in every case there was a reduction of the number of actual units necessary to maintain the service by increasing the individual mileage of the unit.

Economy at Engine Terminals

From the reports it is evident that the cost of handling power per dispatchment varies largely in different parts of the country. This variation being readily understood when it is considered that some terminals are so-called "turn-around" points, while other terminals are practically back shop maintaining points, and it is only natural that costs should vary widely under such conditions. Numerous examples could be sighted in connection with this cost, the Committee feeling there are several angles to be considered. For example: At one large Eastern terminal the present cost of dispatchment is in the vicinity of $12 and the present mode of operation reduces the dispatchments from that point by 28 per day; in other words, it can be claimed that there is a direct saving at this point of $336 a day, which amounts to approximately $10,000 per month saving resulting from running the engines over two divisions. The Committee desires to suggest that it is altogether proper to claim the present cost per dispatchment when multiplied by the number of dispatchments saved, as a saving to be credited to the extension of locomotive runs.

Still another angle which should be considered in the cost of handling at terminals is brought out by the questionnaires in that the cost per individual dispatchment resulting from this change seems to have decreased materially at many points. For the sake of the discussion the Committee feels that this decrease in cost per dispatchment results from the more efficient handling of the particular terminal, due probably to reducing its capacity to normalcy. One example of this increase in efficiency at the terminal is shown by the reduction in cost per locomotive dispatched from $8.39 to $4.20, another reduction from $12.99 to $11.72, another from $16.60 to $12.70, and another from $14.03 to $9.89.

Items Entering to Terminal Reduction of Cost

The Committee feels that the individual items which go to make up the saving at terminals because of decreased dispatchments should be considered briefly. For example: The engine which is run over two divisions or more does not receive at the intermediate points the attention of the wipers, nor the attention of the machinists' inspectors, boiler inspectors, of the dope and grease gangs, scoop inspectors, and air brake inspectors, nor is it necessary to pay hostlers to move the engine around the terminals, as well as the attention of the ash pit and coal dock men. The Committee claims that in connection with these various items it does not cost any more to do this work at one terminal where the engine stops, on account of not having it done at the point by which the engine runs.

Increasing Railroad Capacity

The railroads of the country today are handling heavier traffic than at any time in their history. They are being haunted on all sides by the legislative committees and are endeavoring in various ways to offset these attacks by showing more efficient management and the handling of larger business in the plants as they exist at this time. Last spring the railroads, through their Executives' Committees, laid plans for increasing the capacity of their plants for the purpose of preparing for the tremendous business which is now being handled, and the Committee desires to advance the suggestion of extending the locomotive runs as one means of increasing the capacity of the railroads.

Referring again to the New York Central as an example, at one of the Eastern Terminals where passenger facilities are overcrowded, it is noted that by means of running engines through this terminal there are saved for each eastbound engine operated three movements per engine through an interlocking plant and four movements for each westbound engine through a second interlocking plant, two movements per engine over a draw bridge, and, in fact, this particular terminal was so crowded at times that it was almost impossible to find storage room for locomotives while awaiting trains when power was changed at this point. The locomotives running through this terminal avoided the necessity of having to find this storage room. At another point on the New York Central where freight and passenger business was handled through the same terminal considerable reduction in terminal delays to freight trains has been avoided by running passenger engines through this terminal.

The Committee feels that the importance of increasing the capacity of the plant as suggested by longer runs by locomotives should be given serious consideration.

Details in Making Longer Runs Successful

In connection with extending the runs of locomotives consideration should be given the matter of grease on main pins, additional coal on hand for fireman to use and additional lubricator capacity. The reports from questionnaires indicate that in places it is necessary to fill grease cups at intermediate terminals, at other points it is necessary to shovel coal ahead, while some of the roads report that coal passers on the engines are getting away from this necessity. Also no attention is given to the fire, other than educational program for the fireman and similar educational program for the engineman in regard to inspection and oiling of locomotive. Several railroads report that a stop is made for additional coal en route. The Committee feels that proper attention in design of coal space and possibly mechanical coal passers would overcome to a large extent any drawbacks which might develop on individual routes relative to the coal problem.

In connection with the educational program for enginemen and firemen it has been found advisable on most roads undertaking the extension of the mileage of runs to begin this operation on a few runs and gradually increase the number until all the runs available are so operated. On the New York Central it was found necessary to instruct engineers to watch the lubrication more closely than had been necessary in regard to both cylinder and journal lubrication. Enginemen were also instructed to report personally to the relieving engineer relative to locomotive conditions as observed during his operation of the run, and at the final terminal the report of the enginemen was made to include all items observed by all engineers operating the engine since leaving the initial terminal. It was also found necessary to follow these terminal reports quite closely to insure that the enginemen were giving it their proper attention. The operation on the New York Central with long runs as well as the short ones has been to have engines regularly assigned to trains, which means that from four to six different crews regularly operate the same engine on the same group of trains. The most difficult portion of the educational program of the fireman was in connection with proper sort of fire into the terminal at which he was relieved. This instruction plan changed his manner of firing to insure as nearly as possible at all times a clean fire, meaning with some grades of coal a slight shaking of the grates possibly twice on the division, a division of 150 miles, while with other grades of coal a slight shaking of the grates possibly three or four times. By building up long run service gradually and supervising it closely, these items of lubrication, work reports and fire conditions have been eliminated to the extent that no more trouble is experienced with them than was experienced on the shorter runs.

In view of the fact that the question might be raised relative to the equipment in use on the longer runs, mention is here made of the fact that the New York Central engines in this service are modern high wheel engines having superheaters, brick arches, water scoops, wheel reverse gears, and boosters.

The reports from the extension of runs on the New York Central indicate that at the start when the few trains first handled in this service were operated and the supervision was very close, the engine failures were reduced very materially, and at the present time when all trains which can be handled are so operated, the engine failures apparently are not effected by the mileage which the locomotive makes during its individual run. Analysis of a large number of these locomotives show that the majority of the failures to a very great extent take place on the first division over which the locomotive operates. The analyses further prove the statement that the mileages of the individual runs have little or no effect upon the number of engine failures accumulated.

Effect on Schedules

From the questionnaires the information is gathered that the effect on the schedule of the locomotive in so far as its terminal time is concerned has been slightly increased. The time allowance at terminals for instance on one road increased from 6 hours 55 minutes to 8 hours 29 minutes; another road reports an increase from 7 hours 30 minutes to 10 hours 8 minutes; another road reports at one end of the run terminal time of 6 hours 40 minutes, and at the other end of the run terminal time of 15 hours 45 minutes. One road reports an average terminal time of 6 hours, this including only running repairs; another road reports terminal time of 12 hours; another from 7 to 9 hours, while another road reports a short turn-around of 3 hours and long turn-around from 10 to 12 hours.

The effect on passenger train schedules is nil. It has been found that the terminal time allowed through passenger trains is practically sufficient to do whatever work has been found necessary on the engine, and in a great many cases this work is completed in a shorter time than would have been required to change engines at the intermediate terminal. This work, as before mentioned, includes the shoveling ahead of a small amount of coal, filling of grease cups on main pins, and possibly the use of a small amount of free oil on journal bearings.

Relative to the effect on schedules of passenger trains resulting from longer runs, it might be of interest to cite the schedule of the Twentieth Century Limited as operated westbound over the New York Central. This train is given an allowance of three and four minutes at various terminals which was formerly designed as time for changing of power. Under the present method of operation the power is not changed at Albany, Cleveland, and Elkhart, and it has been found that the station allowance at these points has been entirely sufficient to do the small amount of work which is necessary on the engine in lieu of the power change. This work, as before mentioned, includes the shoveling ahead of a small amount of coal, filling of grease cups on main pins, and the usual locomotive inspection and oiling. The service of this train is of a high class and the run of approximately 960 miles is covered in 20 hours, making an average speed of 48 miles per hour, or a running speed when station allowance is made of approximately 49 miles per hour, or when taken into consideration the numerous speed restrictions, track and other operating conditions, means that this train must operate at 60 miles per hour for the greater portion of the trip.

Terminal Savings

As well as terminal savings before mentioned, the importance of the saving in coal which results from increasing locomotive runs over two or more divisions should be given consideration. It is a well-known fact that a large quantity of coal, more or less, is lost in the operation of cleaning the locomotive fire, while also a like amount of coal is necessary in the re-building of that fire, so that it is placed in a proper condition for the handling of its train.

Both of these amounts of coal are saved by running the engine through the terminal. This amount of coal is estimated to be from one to two tons per engine dispatched, and with coal costing from $3.50 to $5 per ton, it is an item of importance in the reduction of expenses. Another item of terminal saving is the cost of deadheading the engine between passenger and freight terminal and the roundhouse. Many of our roundhouses are located at points considerably distant from the terminal and it is necessary to make a mileage allowance for the crews moving these engines back and forth. At one of the Eastern terminals this amounts to 56 cents per dispatchment, and undoubtedly is considerably higher than this at some of the points where engines are run through the terminals.

Another item of terminal saving which should be considered is the cost and difficulty of handling the ashes which accumulate at our large terminals. By reducing the number of fires cleaned at a point, it is always evident that the quantity of ash which accumulates is decreased, and this necessarily means a decrease in cost of handling this material, this cost including, of course, the cost of the equipment necessary to handle the ashes.

In answer to questionnaires, the saving in operating expense on one road amounts to 49 per cent; on another a saving of $5.33 per dispatchment with one-half the dispatchments formerly made in operation, and coupled with this a saving of one-half the locomotives and of one-fifth of the fuel consumption when expressed on a unit basis. Another road reports an estimate of $9,500 per month saving in passenger service and $3,500 per month in freight service. Another road reports a saving of crew expenses of $503 and engine house expenses of $13,962 per month. Another road reports a saving in operating expenses of $8,943. Another road reports a saving of $2,418 per month, while another road reports a saving of $10,000 per month.

Difficulties Experienced by Increasing Locomotive Runs

No information was obtainable from questionnaires as to the difficulties experienced resulting from increasing mileage per locomotive run, possibly due to the fact that these difficulties had been overcome, and once overcome were not looked upon as difficulties. On the New York Central the one difficulty which has given the most trouble has been the item of water. By close supervision and test observations, this difficulty was overcome and very little trouble is experienced in this connection. This item of water and the items covering the educational program for enginemen and firemen, as well as the question of coal and lubrication, represent the total of the difficulties which have been experienced in this new method of operation. The matter of assigned engines to trains is a difficulty present at all times and is probably slightly enlarged by lengthening runs of locomotives, and on the New York Central it has been found necessary to supervise the power assignments rather closely in order to insure an assigned engine on a regular train. The report is signed by the members of the committee, Messrs. W. L. Robinson, chairman; Edward R. Boa, Wm. Daze, D. J. Bergin, J. A. Cooper.

I. C. C. Report Reflects Improved Service

A report just issued by the Bureau of Statistics of the Interstate Commerce Commission shows interesting comparisons of railroad service in August of this year and last. The report is based upon figures supplied by 161 Class I roads. The report shows the following:

	Aug. 1922	Aug. 1923
	Per Cent.	
Locomotives awaiting repair	29.1	19.8
Freight cars awaiting repairs	14	7.8
Miles per car day	21.7	28.2
Average tons per car	26.3	28.5
Average miles per locomotive per day	48.5	60.1
Pounds of coal per 1,000 gross ton miles	150	144

A New Language for the Steam Locomotive

By W. E. Symons

The railways have invested in locomotives about $2,600,000,000.

To feed and clothe them it costs annually about $1,149,000,000.

In the item of lubrication alone it costs annually more than $9,000,000.

Lubricating engineers working in co-operation with locomotive builders and railway officers have accomplished much in the way of improved methods of use and quality of lubricants, but no definite or specific standards, worthy of their efforts, have been established as to quantity, quality, method of application or use, nor has any definite nomenclature been evolved for the guidance of lubricating engineers.

An Example of the Heaviest Type of Mallet Compound Locomotive

Historical Review

A casual review of the development of the human race reveals a strong tendency to cling tenaciously to certain habits and customs when once formed, although at times it may be clear that other plans, methods or standards, have much merit to commend their use.

In the development of our transportation systems, improvement and expansion have been so sudden, and with few exceptions so efficient, that we have to a great extent almost standardized certain expressions that were hurriedly evolved by the pioneers in this field, but which for some time past have almost become meaningless in modern practice.

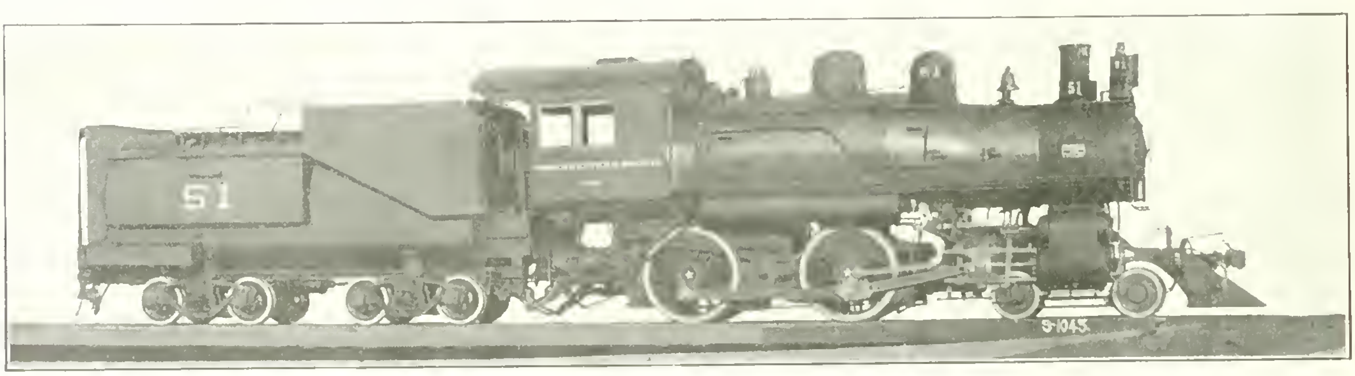
In the matter of names, titles or terms indicative of capacity or other essentials of steam locomotives we have built on, or added to, the original or primitive designation, which was generally based on the diameter of cylinder; thus the 9-10-11 and 12 to 14-inch cylinder grew to 16-18-20-22-24-26 and 28 to 30 inches, while the low pressure cylinders of the larger Mallett articulated engines have cylinders 48 inches in diameter.

Still it is not unusual to hear men high up in the railway or locomotive world use such expressions as: "Oh, yes, this new engine is a whale, she has 30-inch cylinders and tractive power of more than 70,000 lbs.," which in a sense indicates its capacity and suitability for a certain class of service, but is neither definite nor specific.

Designing engineers take into account such factors as ratio of evaporating surface to square feet of heating surface, grate area, cylinder volume, adhesive weight to tractive power, etc., and for their purpose these factors properly observed are essential to a well designed unit.

In the operation of locomotives, however, we meet different problems for solution, and it is in one particular phase of this we find need of more expressive terms, or "A New Language," and that is in the matter of lubrication.

Those who have to do with the lubrication of locomotives are as a rule content with the fact that a larger, more powerful or faster locomotive requires more lubrication than a smaller one at slower speed, and, while pints of oil per 100 miles run, and drops of oil used per minute, have in the past and are still used as standards, or yardstick to measure quantity, and are being diligently expounded, proposed and propounded, both in season and out, yet if there is a lubricating engineer today who knows the area or wearing surface of different locomotives in square inches that requires lubrication, and employs this as a measure or unit of service in determining the proper



A Comparatively Light American Type Passenger Locomotive

GRAPHIC DISPLAY OF STEAM LOCOMOTIVE DEVELOPMENT—LUBRICATED AREA AND ECONOMIC STATUS

CLASSIFICATION — AREA OF WORKING PARTS OF DIFFERENT TYPES OF LOCOMOTIVES AND ACCESSORIES THAT REQUIRE LUBRICATION—WITH CONDENSED STATISTICAL DATA

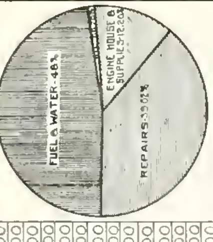
WEARING OR RUBBING SURFACES OF LOCOMOTIVES AND ACCESSORIES THAT REQUIRE LUBRICATION

Representation	Type	Dimension	Cylinders & Valves	Machinery	Valve Gear	Power Stoker	Air Pump	Booster	Tender	Headlight & Reverse Gear	Hub Lateral	Boiler & Side Supports	Total Sq. Inches
ΔooOO	8 Wheel	17×24×62	4300	3600	2000		674		1300	100	2400		14,374
		19×26×69	4900	5100	2200		674		1700	100	2400		17,074
ΔooOOO	10 Wheel	18×24×50	4600	5300	2000		674		1300	100	3400		17,374
		22×28×69	7100	8900	2300		674		2000	100	3400		25,374
ΔOOOO	Switcher	18×24×50	4600	4500	2000		674		1300	100	3500		16,674
		22×28×51	7100	6200	2300		1016		1700	100	4000		21,016
ΔooOOo	Atlantic	22×26×73	4900	6500	2200		674	3126	1700	100	2600		21,800
		22×26×69	6900	7500	2300		674	3126	2000	100	2600		25,200
Δo OOO	Mogul	18×24×50	5000	5000	2000		1016		1300	100	3200		17,610
		21×28×63	6900	6600	2300		1016		2000	100	3200		21,816
Δo OOOO	Consolidation	20×24×56	5100	6400	2200	2313	1016		1700	823	4200		23,852
		26×30×57	8900	10400	2600	2313	1016		2500	823	4200		32,752
ΔooOOOo	Pacific	22×26×69	6900	8700	2300	2313	2097	3126	2000	823	4500	700	33,459
		27×28×79	8800	10500	2600	2313	2097	3126	2500	823	4500	700	37,259
Δo OOOOo	Mikado	22×28×56	7100	9700	2300	2313	2097	3126	2000	823	5000	700	34,459
		27×32×63	9400	11,800	2600	2313	2097	3126	2500	823	5000	700	40,359
ΔooOOOOo	Mountain	27×28×69	8800	12300	2600	2313	2200	3126	2500	823	6000	700	41,462
		28×30×69	9400	12850	2700	2313	2200	3126	2500	823	6000	700	42,612
Δo OOOOOo	Santa Fe	26×32×57	9000	12100	2600	2313	2200		2500	823	6200	700	38,436
		31×32×63	10700	15400	3000	2313	2200		2500	823	6200	700	43,836
ΔoOOOO OOOOo	Articulated	20½×33×32×55	18200	12500	3500	2313	2200		2500	823	9200	3000	54,236
		23×35×32×57	20400	15000	4000	2313	2200		2500	823	9200	3000	61,936
ΔoOOOOO OOOOOo	Articulated	28×44×32×57	25100	19600	4000	2313	2200		2500	823	11,200	3000	70,736
		30×48×32×56	26800	24600	4500	2313	2200		2500	823	11,200	3000	77,936

SQUARE INCHES OF RUBBING SURFACES IN 20-40-60-80 & 100 MILES RUN

Type	20	40	60	80	100
8 Wheel	87,296,800	174,593,600	261,890,400	394,187,200	436,484,000
	97,317,700	194,635,400	291,953,100	389,270,800	486,588,500
10 Wheel	132,525,800	265,061,600	397,577,400	530,103,200	662,629,000
	156,450,000	312,900,000	469,350,000	625,800,000	782,250,000
Switcher	123,319,800	246,639,600	369,959,400	493,279,800	616,599,000
	176,197,700	353,395,400	528,593,100	704,790,800	881,028,500
Atlantic	116,199,700	232,399,400	338,599,100	464,796,000	580,998,500
	142,818,000	285,636,000	428,454,000	571,272,000	714,090,000
Mogul	134,773,300	269,546,600	404,319,900	539,093,200	673,866,500
	150,522,000	301,044,000	451,566,000	602,088,000	752,610,000
Consolidation	135,455,700	270,911,400	406,367,100	541,822,800	677,278,500
	219,220,700	438,441,400	657,683,100	876,882,800	1,096,103,500
Pacific	156,642,000	313,284,000	469,926,000	626,568,000	783,210,000
	171,622,000	343,244,000	514,866,000	686,488,000	858,110,000
Mikado	194,922,000	389,844,000	584,766,000	779,688,000	974,610,000
	224,912,000	449,824,000	674,736,000	899,648,000	1,124,560,000
Mountain	204,632,000	409,264,000	613,896,000	818,528,000	1,023,160,000
	216,976,000	433,952,000	650,928,000	867,904,000	1,084,880,000
Santa Fe	238,058,000	476,116,000	714,174,000	952,232,000	1,190,290,000
	265,476,000	530,952,000	746,428,000	1,061,904,000	1,327,380,000
Articulated	381,826,000	763,652,000	1,115,478,000	1,527,324,000	1,909,130,000
	428,890,000	857,780,000	1,286,670,000	1,715,560,000	2,144,450,000
Articulated	527,680,000	1,055,360,000	1,583,040,000	1,110,720,000	2,638,400,000
	600,000,000	1,200,000,000	1,800,000,000	2400,000,000	3,000,000,000

MY LIVING EXPENSES FOR THE YEAR 1921 WERE $1,149,130,969.00



NOTE COLUMN (12) SHOWS TOTAL AREA OF LOCOMOTIVE & ACCESSORIES THAT REQUIRE LUBRICATION. COLUMNS 5-6-7-9-10 & 11 NOT INCLUDED IN COLUMNS 13 to 17 INC. RUBBING SURFACE OF AIR PUMPS AT NORMAL SPEED FROM 80,808 TO 288,200 SQ. INCHES PER MINUTE. HUB LATERAL FROM 200 SQ. INCHES ON SMALL TRUCK WHEELS TO 1000 SQ. INCHES PER PAIR OF DRIVING WHEELS. RUBBING SURFACE OF POWER STOKER AT NORMAL SPEED-43,000 SQ. INCHES

VOICE OF THE LOCOMOTIVE

I AM COMPOSED OF 66,721 UNITS YOUNG & OLD GIANTS & DWARFS

I AM CLASSIFIED AS FOLLOWS
FREIGHT - 60% = 40,032
PASS - 23% = 15,345
SWITCH - 15% = 10,008
MSCLS - 2% - 1,336.

WHAT I DO: I TRAVEL ANNUALLY MORE THAN ONE BILLION AND HALF MILES OVER MORE THAN 250,000 MILES OF RY. I HAUL 2,400,000 FREIGHT CARS. I HAUL 56,000 PASS CARS. I PRODUCE 40,000,000,000 PASS MILES. I PRODUCE 400,000,000,000 FRT TON MI. I HAUL 15,000,000 TRAINS PER YEAR AND I EARN FOR MY OWNERS ABOUT $6,000,000,000.00 I AM THE LIFE OF A NATION

I MUST BE FED AND CLOTHED, AND MUST ACCOUNT FOR EVERY MINUTE OF TIME

Division of Time		Per Cent 20 40 60	% of Time %
12'40"	Round house, running and classified repairs		527
5'50"	Road delays and all terminal detention		243
5'30"	Actual running time earning revenue		230
24 hrs	← TOTAL →		100%

I AM KEPT IDLE WAITING TO MOVE ALMOST 6 HOURS EACH DAY. MY ACTUAL RUNNING TIME IS ABOUT 5½ HOURS. SEE WHAT IT COSTS TO FEED AND CLOTHE ME TO WORK LESS THAN 6 HOURS PER DAY.

Items	Amount	Per Cent
Repairs	$448,491,257	3902
Fuel & Water	550,472,953	4800
Eng. House & Supplies	141,078,772	1220
Lubricants	9,087,987	0078
Total	$1,149,130,969	100%

MY PHYSICAL ANATOMY IS COMPOSED OF MANY THOUSAND SEPARATE PARTS FABRICATED INTO ONE OPERATING UNIT WHICH CAN AND DOES SUFFER FROM BOTH NEGLECT AND ABUSE. MY MUSCLES, JOINTS AND RUBBING OR WEARING PARTS CONSTITUTE MANY THOUSAND SQUARE INCHES, WHICH IN 100 MILES RUN AMOUNT TO MANY HUNDRED MILLION SQUARE INCHES. IT COSTS MORE THAN $9,000,000 ANNUALLY TO LUBRICATE ME

I HAVE DELIVERED ONE HORSE POWER WITH LESS THAN TWO LBS OF COAL. I EXCEEDED A SPEED OF 100 MILES PER HOUR MORE THAN 20 YEARS AGO. I AM SUCCESSFULLY MAKING LONG CONTINUOUS RUNS OF 500 TO 900 MILES. I EARN AN AVERAGE OF MORE THAN $100,000.00 ANNUALLY, RUNNING LESS THAN 6 HOURS PER DAY, AND —

I WONDER WHEN UNDER HEAVEN THE PROFESSIONAL "ANTI-RAILWAY POLITICIAN" CAN BE SILENCED LONG ENOUGH FOR A RESTORATION OF PUBLIC CONFIDENCE, TO MAKE IT POSSIBLE FOR MY OWNERS TO FINANCE NEEDED ADDITIONS AND BETTERMENTS SUCH AS — DOUBLE TRACK, YARDS, SHOPS, TERMINALS, ETC. SO I CAN WORK MORE AND LOAF LESS. SO I CAN MAKE MORE PASS AND FRT TON MILES. SO I CAN PRODUCE MORE GROSS & NET REVENUE. SO I CAN CONTRIBUTE STILL MORE TO THE GROWTH AND PROSPERITY OF THE NATION

I REPRESENT AN INVESTMENT OF ABOUT $2,600,000,000.00 OR ABOUT 13% OF THE TOTAL VALUE OF ALL RAILWAY PROPERTY. WITH IMPROVED FACILITIES FOR MY CARE AND OPERATION, I CAN INCREASE MY HOURS OF SERVICE, REDUCE MY IDLE TIME AND INCREASE THE RETURN ON INVESTMENT IN ENTIRE PROPERTY.

amount of lubricant for a certain locomotive, his name and address is unknown.

One English authority makes the usual guess as to quantity required by recommending "*four drops* per minute to an axle, and *six* to a *cylinder* or valve chest," with no indication whatever as to size of axle or cylinder, steam pressure and weight.

It is safe to assume there is *not* a man in the lubricating business who knows, or could give a reasonable close estimate of the lubricated area of different engines, even though well informed on locomotive maintenance and operation. In the last analysis, however, the parts to be lubricated should at least be known if not expressed in square inches, when estimating quantity of lubricant, for the obvious reason that the unqualified term of "diameter in inches" does *not* mean anything.

The graphic tabulation presented herewith not only serves to emphasize the growth or development of the steam locomotive in this country, but brings out clearly the wide range of difference in lubricated areas between engines in the same class of service. For example, it will be noted that between the eight-wheeler and large Pacific the difference is as much as 159 per cent, while in the different types the difference is still greater, reaching in the extremes about 354 per cent.

There is much food for thought, study and action, in the economic status of the locomotive as briefly outlined at bottom of tabulation.

Hours of Service of Locomotives

The actual number of hours in each 24 that locomotives are under way producing passenger *car miles* or *freight ton miles* is surprisingly small, and while the average here shown may, and probably does not represent conditions on all lines, yet it is believed to be fairly representative of the United States, and should be the means of arousing activity among those responsible for, and interested in, this great economic question of *IDLE CAPITAL*.

From the time a locomotive is coupled to its train or delivered to transportation department until completion of run and delivery to mechanical department, it may be said to be "in service," and while some delays at terminals or on line due to traffic fluctuation, accidents, etc., are unavoidable, yet the sum total of these is *too high* and should be reduced, to the end that this invested capital of say about two and one-half billion dollars, should *work more* and *loaf less*, thus increasing the efficiency of the entire transportation unit. It is *passenger miles* and *freight ton miles* that put money in the company's treasury, and a train standing still is taking money out of the owner's pocket, to meet interest charges, depreciation, taxes, wages, etc., that accrue every hour in the 24.

Individual Engine Basis

In addition to the six items of expense, shown on the disc chart, three other items are here included with a sub-division showing the average amount expended on, or in, the operation of each unit per year.

A study of this table, in connection with comments below, should arouse interest in this matter:

Items	Amount	Aver. per Engine
Fuel and Water	$550,474,953	$9,657
Repairs	448,491,257	6,706
Engineers' and Firemen's Wages	272,132,066	4,774
Engine House and Supplies	141,078,772	2,824
Depreciation	41,579,795	623
Lubricants	9,087,987	159
Total	$1,462,842,830	$24,743

Salient Points

The average annual earnings for each engine is more than $100,000.

The average cost of maintenance and operation of each engine is about $24,743.

The average annual cost of fuel, water and repairs is about $16,363.

The average cost for lubricants per engine is about $159.

The average cost of lubrication per 1,000 miles run is about $6.

Repairs, fuel and water, approximately $16,363 per year, is more or less influenced by the quality of lubricants and degree or standard of efficiency attained in correct or proper methods of application or use. This item alone amounts to the comparatively insignificant sum of $159 per year, or less than one per cent (1%) of these two principal items, and notwithstanding the importance of this matter, and the need of standardization, there is no other feature of locomotive design, operation, and maintenance that is so sadly deficient in this respect.

Tentative Plans

The situation would seem to justify intruding the following suggestions as a tentative working basis in attacking this problem: (a) Determine by exhaustive service and laboratory tests the more suitable lubricants for valves, cylinders, machinery and accessories under all conditions of service, with identification, description and specifications for each, so clear and concise as to render mistake on the part of the user impossible, except in case of carelessness on his part. (b) Determine in the same manner as in (a) the most efficient or suitable methods or devices for the application of all different lubricants used, and respective quantities required under the various conditions of service. (c) The work embraced in (a) and (b) to be placed in the hands of a committee or jury of neutral experts, no member of which shall be interested in the manufacture or sale of lubricants or devices used in connection therewith, of any kind whatsoever. Anyone disqualified to serve on this jury of investigation and determination, will be invited to submit samples of any and all lubricants or devices employed in its application or use, and in other ways co-operate with the jury by furnishing detailed information, and being present when desired. (d) This committee or jury to co-operate with Mechanical Division No. V, A. R. A. The expense preferably to be by contributions from or mutual agreement between certain trunk line railways, who realize the importance of this question, and the benefit that would result from their efforts.

Advantages of Oil as Fuel for Locomotives

Report of a Committee to the Traveling Engineers' Association

The most important consideration governing the use of oil as a fuel is the relative cost and extent of supply. At the present time the production of oil exceeds consumption and the prevailing price coupled with the advantages of fuel oil invites consideration of its extended use as a locomotive fuel.

During the year 1922 a total of 44,752,344 barrels of fuel oil were consumed by locomotives in the United States on the principal railroads, which showed a gain of over 4,000,000 barrels over 1921. The largest consumption was shown in the Middle Western and Southwestern District, totaling 21,512,851 barrels in 1922. The Northwestern District totaled 3,783,514; Southern District, 916,951 barrels; Eastern District, 134,763 barrels. 32,000,000 barrels of the total was domestic oil and 12,000,000 barrels was imported from Mexico.

The fuel oil in general use is topped crude petroleum from which the lighter and more volatile constituents have been removed by distillation, leaving a heavier and safer oil for fuel. Fuel oil, unlike coal, varies very little in heat value, averaging 18,750 B. T. U. per pound.

Oil has a higher heat value per pound than coal. For the same number of heat units, fuel oil weighs approximately 30 per cent less than coal and only occupies about 50 per cent as much space. Some of the modern oil-burning locomotives have an oil capacity equivalent to over forty tons of coal. In passenger service these locomotives can haul a 750-ton train over 650 miles without fueling en-route.

Considering coal of 11,500 B. T. U. per pound and oil of 18,500 B. T. U., 3.70 barrels of oil are equal to a ton of coal on a heat basis.

It is the heat content of the fuel actually utilized rather than the heat that is available in fuel that is of the most concern. In this respect fuel oil has a decided advantage in having a higher evaporative efficiency than coal, as there is no loss to the ash-pan or loss in cinders and a smaller loss in unburned gases. On an evaporative basis approximately three barrels of oil are equal to a ton of coal on the above heat values of the two fuels.

A check of fuel consumption under operating conditions showed that 3.32 barrels of oil was equal to one ton of coal 12,500 B. T. U., and 2.68 barrels equal to one ton of coal 9,810 B. T. U., the heat value of the oil being 18,500 B. T. U. These figures take into account the various losses.

Efficient Design

All oil-burning locomotives were primarily designed to burn coal, and notwithstanding the high boiler efficiencies attained with the present oil-burning locomotives, some authorities believe that higher efficiency could be attained if the oil-burning locomotives were especially designed to burn oil.

In the combustion of oil the particles of oil are on their way to the flues before they are even partially consumed. If these particles were attached to a bed of coals a supply of air could easily complete their combustion, but with oil a mixture of air and the ignition must take place in a very limited time, therefore it is realized that large furnace volume is essential to the burning of fuel oil. While the dimensions are of minor importance to the volume, it is evident that flame-way must be provided of sufficient length to prevent unconsumed particles of fuel striking the flues.

With oil fuel the productivity of the locomotive is increased, as either the tonnage or speed are increased, due to the fact that with oil the maximum boiler capacity is available at all times and the engineer does not have to work the engine below the capacity of the man with a scoop shovel. The tonnage increase is generally accepted as 15 per cent. Less time is required to turn an engine.

operating internal combustion cars, three operating storage battery cars, and two operating electric branch lines. From the data collected by the Committee above referred to and which was presented at the last meeting of the A. E. R. E. A., we have abstracted and present here in tabulated form data as to (a) Number of steam railways using gasoline, kerosene or distillate, storage battery and electric cars on branch lines or in auxiliary service. (b) Seating capacity. (c) Average speed on M. P. H. (d) Average distance between stops. (e) Number in crew. (f) Horse-power of engine. (g) Number road trips per day, etc. The table cover cars placed in service 1895 to 1923 or 28 years.

Items	Number in use	Seating capacity Range of:	Average speed M.P.H.	Average distance between stops	Any trouble to stop	No trouble trips	Engine H.P.	Number in crew
Gasoline cars	99	16 to 107	10 to 40	1M to 12M	8-yes 25-no	1 to 24	31 to 200	1 to 4
Kerosene or distillate cars	3	62 to 84	24 to 30	2.8 to 6.75	1-yes	1 24	.. 200	3 to 4
Storage battery	8	26	15	.25		1	10	2
Branch or aux-service		50	22	4.5		11	150	..
Electric cars for branch or aux-service	112	32 70	15 22	.5 1.9			40 160	2 to 4
Total motor cars	222							

*Includes 60 interurban cars of Southern Pacific at Oakland, Cal., and 35 of N. Y., N. H. & H. originaly operated with steam locomotives. The reasons assigned by the various companies.

The reasons assigned for changing from steam train to motor cars by the different companies varied. Some simply said; economy, while others went more into detail. The Southern Pacific which shows 60 in use gave the following reasons; quicker acceleration, resulting in reduction in running time; increased flexibility of operation; reduction of noise and smoke in congested districts; reduced operating costs.

Temperature of Journal Brasses

Very little attention is paid to the ups and downs of journal brass temperature until it rises to a point where the waste begins to smoke, as an evidence of a hot box. But that there is a constant variation up and down during a run is not usually appreciated.

The accompanying diagrams give the variations in journal brass temperature on a local passenger train on a round trip run over a 140 mile division of the Canadian Pacific Railway. The average speed of the train was remarkably uniform and was about 21 miles per hour. This means, of course, that the train was probably running 40 miles or more per hour at times. But apparently speed had little to do in this case with the rise in temperature of the brasses.

At the start from Montreal the brass had a temperature of 50 degrees Fahr. This was evidently cool enough to make the oil sluggish in the waste and the lubrication was not all that it should be so that the temperature rose rapidly for 40 minutes until it had reached nearly 200 degrees. Then it continued to climb for an hour and 25 minutes longer when it had reached a temperature of 230 degrees. By that time the oil in the waste was thoroughly warmed and was being carried up to the journal in sufficient quantities to effect a high grade of lubrication.

Under those conditions the brass temperature started to fall and fell very steadily until the end of the run was reached when it was down to 104 degrees.

At the start of the return run the temperature had fallen to 52 degrees or almost to that at the start.

Again the chilled oil failed to flow freely and we find an immediate rise of brass temperature as soon as the

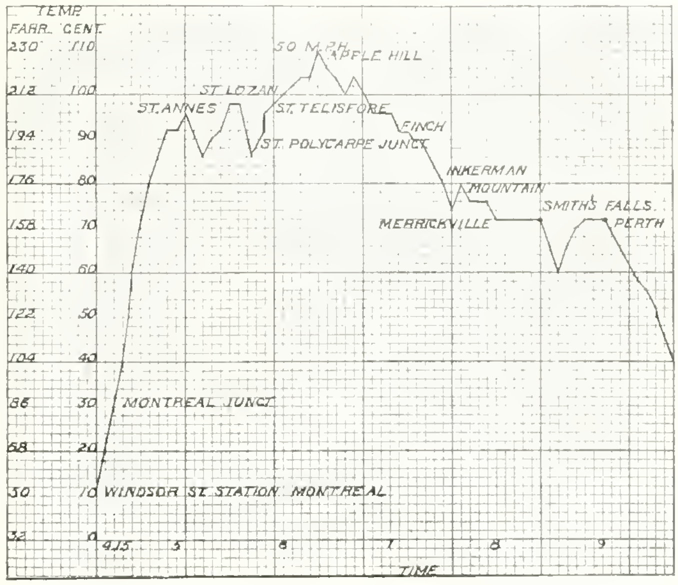


Diagram Showing Rise in Journal Brass Temperatures

train started. In a half hour it had risen to 103 degrees. This was followed by rises and falls for an hour and 45 minutes when it reached the maximum temperature of 170 degrees. It then fell rapidly and was down to 103 degrees when the train stopped.

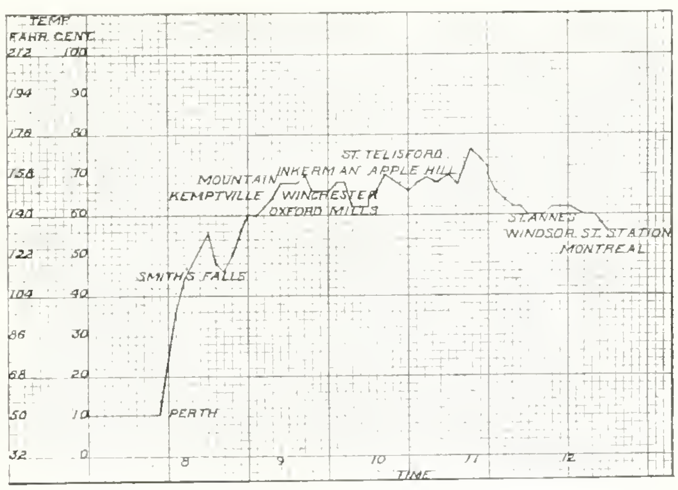


Diagram Showing Temperatures of Journal Brasses

The diagram shows very markedly the sensitiveness of the journal brass to the character of the lubrication which it is receiving, and how its temperature is constantly changing.

Exposition of Power and Mechanical Engineering

The second exposition of Power and Mechanical Engineering is to be held in the Grand Central Palace, New York City, from December 3 to December 8, inclusive. This exposition is being held at the same time that the meetings of American Society of Mechanical Engineers and the American Society of Refrigerating Engineers are being held. In addition, the National Association of Stationary Engineers and affiliated bodies are also organizing the interest of their membership in this exposition.

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Wanted a Chance

It is a common experience and observation that the jealousy of a small man of authority in an industrial concern will prevent a subordinate employe of ability from showing what he can do. There are apt to be insinuations and innuendos that will be just enough to keep up a feeling of suspicion or even semi-hostility in the mind of a manager, and tend still further to prevent the man below from having his chance.

This is about what has been happening in the railroad world for many years. Here the railroad manager may be likened to the competent employe, the politician to the jealous superior and the public to the ownership. And it is regretfully suggested that, like some managers of industrial concerns, this dear public does not know very much about the details of the business which it is attempting to run. So, lacking first hand intimate knowledge, it has to take somebody's word as to how things are going, and, being composed of just the average of human beings, it is not given to any deep thinking and careful analysis for itself, and is more disposed to think and cherish evil report than good.

So when the politicians told the public how much it was suffering at the hands of the rapacious railroad managers it eagerly believed them and straightway applauded every effort made to prevent the said managers from having a chance to show what they could do. The public even went so far as to remove every chance and place their work in the hands of the political superior.

It was a costly experiment that of shifting the authority from men who know to men who didn't, and the result was what was to have been expected. The whole concern came very close to ruination. But it is an ill wind that blows no good. And this particular wind blew aside the clouds by which the weaknesses of the politicians had been concealed, and brought out in startling distinctness the abilities of the men who really knew the railroad business.

Then came the revulsion of feeling and the desire to give these men and the properties they represented a chance to show what they could do.

Anticipating this year the largest traffic in history, the railroads of the United States on April 5 unanimously adopted their "constructive program," the major purpose of which was to handle this traffic with promptness and efficiency, and, if possible, without delays due to car shortage.

The traffic hauled so far has been even greater than anticipated. For sixteen weeks car loadings exceeded one million cars; yet ever since June there has been a surplus of cars in good condition available for more traffic, if offered.

In the peak week ending September 29 car loadings amounted to 1,097,000 cars, and on the same date there was a gross surplus of approximately 41,000 cars.

1. The total cars of revenue freight loaded for the thirty-nine weeks from January 1 to September 29, inclusive, show an increase of 19 per cent. over the same period in 1922, 28 per cent. over 1921, and 10 per cent. over the corresponding period in 1920.

2. The thirty-nine weeks' total loadings this year were 37,308,891 compared with 31,307,098 in 1922, 29,135,147 in 1921, and 33,788,565 in 1920, the previous record year.

3. In sixteen of the eighteen weeks' period, from May 12 to September 29, car loadings exceeded the million mark, and in these weeks there was an average surplus of more than 50,000 cars.

4. The loading of 1,097,274 cars in the week ended September 29 was the highest weekly loading on record, exceeding the previous peak week of September 1 this year when 1,092,567 cars were loaded.

5. In the first nine months of this year the railroads installed in service 134,636 new freight cars and 2,963 new locomotives. On October 1 64,601 new freight cars and 1,242 new locomotives were still on order.

6. In the first nine months of this year freight cars awaiting repairs were reduced from 216,011, or 9.5 per cent. of the total on January 1, to 151,332, or 6.7 per cent. on October 1. Cars awaiting heavy repairs were reduced from 164,041, or 7.2 per cent. on January 1, to 118,563, or 5.3 per cent. on October 1. The constructive program called for a reduction of cars awaiting heavy repairs to 5 per cent.

7. In the first nine months of this year locomotives awaiting repairs were reduced from 15,549, or 24.1 per cent. of the total on January 1, to 9,823, or 15.3 per cent. on October 1. Locomotives awaiting heavy repairs were reduced from 13,587, or 21.1 per cent. on January 1, to 8,789, or 13.7 per cent. on October 1. The constructive program called for a reduction of locomotives awaiting heavy repairs to 15 per cent.

8. The average number of tons loaded per car in August, the latest month for which these figures are available, was 28.6 tons. This was an increase of .1 of a ton over the July figure this year, and an increase of 2.3 tons over August, 1922, and 1.2 tons over August, 1921. It was the highest loadings per car this year with the exception of January.

9. The average daily movement of freight cars in

August, the latest month for which these figures are available, was 28.1 miles. This was two-tenths of a mile greater than in July this year, 6.4 miles greater than in August, 1922, and 5.4 miles greater than in August, 1921.

They asked for a chance and if it is given with a slackening of some of the regulation still hampering free action, there is little doubt that the outcome will be a satisfactory one. All that is asked is a chance, and a chance not saddled with a demand that a miracle be performed in a week or month or year. With this in view, it would be well for the public to stand aside for a time and assuming the attitude of an impartial witness adopt as its slogan "Give the railroads a chance."

And we may add, "Give the Transportation Act a thorough trial."

The Ten-Wheeled Locomotive

A number of years ago there was a rapid increase in the number of ten-wheeled locomotives built. They were extensively used for heavy passenger service and for fast freight. They were, however, rather crowded out of this work by the Atlantic and Pacific types, especially the latter. This was probably due to the heating surface and grate area requirements of the boiler. It was simpler to get the required grate area by using a trailing wheel beneath the firebox than it was to raise the box above the driving wheels. But whether this be the true reason or not, the fact remains that after a few years the ten-wheeled engine seemed to fall into disrepute, and few were built.

It is for this reason that the engine of this type built by the Pennsylvania Railroad and illustrated in another column is of special interest. As far as tractive effort at starting is concerned it compares favorably with the heavy Pacifics of the same road, but the smaller amount of heating surface, the smaller driving wheels, and the small cylinders make it incapable of the same long sustained effort at high speeds. But that is not what it was built for. It is for local passenger service where the machine has a chance to stop and catch its breath and as such it will undoubtedly be far more satisfactory than its big brother for that service.

The probability is that there are many schedules in this country that are now being worked by engines for heavier than the actual necessities of the case demand and that the management could well afford to turn aside from the Pacifics or Atlantics that are now in use to a ten-wheeler like this, whose prototype may have been discarded for them.

The Patent Situation

It is doubtful if the framers of the original patent laws anticipated the tremendous number of patents that would be issued in the course of the first hundred years. Least of all did they realize the number of worthless inventions that would ask for protection. But the numbers have piled upon each other until the office is swamped by the work thrust upon it. Recently a petition has been presented setting forth the congested state of affairs and asking that the pay of the examiners be increased as well as their numbers so that it may not only be possible to expedite the work but obtain and retain a better class of men for the work.

It is possible that if the public and inventors understood more as to what a patent really means, the number of applications would be fewer. The French state on every patent that it is issued without any guarantee on the part of the government, that it is a valid patent. The United States issues its patents with the same lack of guarantee, but says nothing about it, and leaves the patentee to find it out as best he may and often to his cost. A patent in this country is only really valid after it has been through an expensive course of litigation.

Then it would be well to discourage patent applications for minor changes in existing devices, patents that are really of no value. A case came up a few years ago where a manufacturer had patented every change he had made in his structures, and had kept a patent lawyer busy for years. On the settlement of his estate these hundreds of patents were turned over to an expert for valuation. All but one were discarded as of no value whatever, and there was no market for even that one.

Then, there is the constant uncertainty as to the real status of a patent with the result that the Federal courts are crowded with infringement suits. It was because of this uncertainty and the abuses that grew up under it that the Eastern Railway Association was formed.

The association was formed in January, 1867, by the representatives of a number of the railroads of New England, New York, New Jersey, Pennsylvania, Delaware and Maryland. Its object was to promote railway interests, chief among which was the protection of its members against unjust claims made for invalid patents. Its organization was due to the fact that, prior to 1866, a large amount of money was paid to patentees and speculators in patents by railroad officials, for the settlement of claims which, had they been properly investigated, probably could not have been legally enforced. This, in a great measure, was owing to the lack of knowledge of patent law on the part of the railroad officials, and, also, to their inability to devote the time necessary for a thorough investigation of such claims. As a consequence, settlements were frequently made on any terms obtainable. Many settlements thus made proved to be of no value, the party with whom the settlement was made not being the true inventor, or the patented device for which a license was purchased, being itself an infringement of some other patent, thus necessitating another settlement with some other claimant. The result of such a method was to embolden unscrupulous parties to sell a license to some road, at a low figure, as an inducement to purchase, using the prestige of such a sale as a means whereby a larger sum might be obtained elsewhere. The result was that all manner of claims were being made under patents covering all kinds of railroad equipment and had become a source of continual annoyance and large expense, to the officials of all railroads of the country. The result was the formation of the Eastern Railway Association as a matter of self-defense.

From the date of its formation until January 1, 1879, the headquarters of the association were in the office of the president of the Connecticut River R.R. at Springfield, Mass. They were, then, moved to the Boston & Lowell depot in Boston. On November 1, 1880, they were transferred to the Grand Central Station in New York, and on May 1, 1883, they were moved to Washington, where they have since remained. Its work is now as it has been throughout the whole of its existence, devoted to examining and reporting on the validity of patents for the benefit of its members, and of contesting such suits as may be brought against the railroad companies.

The Pennsylvania Railroad was one of the earliest members of the association, having joined in the second month of its life, February, 1867. Mr. Theo. N. Ely, then superintendent of motive power, became a member of the executive committee, as a representative of the Pennsylvania Railroad on December 14, 1884, and remained on it until May 14, 1902. From May 14, 1884, to May 11, 1904, he was vice-president, when he was elected president, and remained such up to the time of his retirement from railroad service. So that, for more than thirty years, the Pennsylvania Railroad was through him closely associated and identified with the management of the association, and was an important factor in the policy pursued which was that of making a thorough and impartial investigation into the validity of patents on railway appliances and reporting the same to its members.

As the law now stands it provides for the equivalent of new interference trials, which means that after a would-be patentee has been in litigation in the Patent Office and Court of Appeals he may have to go to the Federal courts and do it all over again. This imposes unnecessary hardship and opens the way for fraud.

As most patents are either invalid or of limited value, the patent office when issuing the same should indicate therein the ascertained limitations thereof, as notice to intending purchasers, licensees and industry generally. This would involve practically no additional expense and would obviate much fraud, misunderstanding, and subsequent litigation.

Another practical and very desirable change in our present system would be the legalization of patent insurance so that the manufacturer, dealer, inventor, or investor, can, by payment of suitable premiums, procure a policy of insurance against infringement. This would protect the patentee or producer against infringement of his patent rights by others, and insure him against loss resulting from his infringement of the patent rights of others in the manufacture of his own patented products. Such an insurance company would naturally refuse policies on many patents, and the public might do well to avoid investments in such patents. Also, the insured patents would prove to be much safer and more attractive investments, and meritorious inventions would thus find available markets without sacrifices now necessary.

In short our patent system has become so large and so complete that a thorough revision of its laws will be required, in order that it may afford suitable protection both to the inventor and the public.

A New Yardstick for Lubricating Engineers

Elsewhere in this issue will be found a tabulation with charts on locomotive lubrication and the economic status of the locomotive that should not fail to arouse interest in a subject of importance to all those who have to do with lubrication or operation of locomotives.

There is probably no other single item of expenditure in connection with the operation of a railway which so affects other and larger items as that of lubrication, particularly locomotives, and when we consider the wide range of difference in amounts involved, the importance or necessity for, a "New Yard Stick" for the lubricating engineer is at once apparent.

Comparison of costs of lubricating locomotives from a service or 1,000-mile run standpoint shows a difference due to size or capacity of from about $2.00 per 1,000 miles run for small engines, up to as much as $28.00 or even $30.00 per 1,000 miles run for the larger articulated engines, while the average for all locomotives is approximately $6.00 per 1,000 miles run.

From the disc chart presented with the tabulation referred to it might appear to one uninformed that the item of lubrication was too small for inclusion when dealing with problems expressed in hundreds of millions of dollars, and that amount in the aggregate to more than one billion dollars, but when on analysis we find that the nine (9) million dollars paid for lubricants, while less than eight-tenths of one per cent of the living expenses of locomotives, may, if improperly or unscientifically used, easily make a difference of that amount in the $1,149,130,969.00, we then begin to realize the importance of lubrication to a railway, the potential value of the lubricating engineer, and the necessity for more definite standards in handling this important subject.

In the earlier history of our railways, the lubricating question consisted largely of issuing to engine, train and car men such quantities of oil as they either requested or insisted on having, the result being that in some instances small engines with cylinders of only 16 to 17 inches, and with low steam pressure would use as much as one quart of tallow in from 117 to as low as 22 miles. The latter figure being less than 12 miles per pint of valve lubricant, while the quantity of lard or compounded oils used on the machinery and tender was equally as extravagant.

If the use of lubricants on locomotives were as wasteful now as in the above cases (1874), the present cost of lubrication per 1,000 miles run, while impossible of accurate calculation, might be estimated as high as six (6) or eight (8) times the present cost or an average of around $40.00 per 1,000 miles run, and a total cost of all locomotive lubricants of more than $50,000,000 per annum.

Much credit is due those who originated and introduced the plan which resulted in saving the railways many millions of dollars in locomotive and car lubrication, but this commendable fact is no reason why the lubricating feature of railway operation should not have long ago been subject to regulation or solution by well defined rules, standards or specifications that, within certain limits or tolerances, could be used by: (a) The builders of equipment. (b) The owners and users, and (c) The manufacturers of lubricants, and devices used in its application.

Notwithstanding there has been a crying need of something of this kind for the past 25 years, and there are scores of lubricating engineers and oil experts both theoretic and practical, yet they do not seem to produce anything on the above lines.

The following is a striking illustration of the absence of helpful literature on the subject:

One of the most elaborate and best engineers' text books recently issued a new edition, much enlarged and rearranged to apparently meet every known engineering problem. Some thirty-five (35) experts were engaged in its revision. There are 48 pages devoted to locomotives, and 17 pages to lubrication in general. It is a fine book and should be in the hands of every engineer, but as for information on locomotive lubrication, it is only conspicuous by its absence, and this criticism applies to all others who have so completely defaulted in this matter.

The field is broad, in fact almost virgin soil, and if those who speak with authority on the subject of lubrication do not wake up and produce something on constructive lines, as to quality, quantity and method of use, for all conditions of service, they will by their own continued acts of omission, provide a most effective club for any engineer or railway critic to pound them with. Railway and Locomotive Engineering will gladly render any aid in this matter.

Public Benefit From More Railroad Freedom

By Ralph Budd, President, Great Northern Railway

There have been three distinct periods with respect to railroad regulation and public relations: First, prior to 1887 railroad enterprise was on a strictly commercial basis and railroad promotion and growth proceeded with great rapidity and unbridled competition except for state laws. Perhaps some things were done in those days which no one would advocate at the present time and under present conditions, but in a large way it seems certain that the country could not in any other possible manner have secured the great benefits which were so essential to its growth and development at that time as it did from this uncontrolled promotion of railroad enterprise.

The next period, 1887 to 1917, marks the beginning of federal regulation and witness rapid increase in regulation of railroads under the Interstate Commerce Commission. It is significant that during this period more and more regulations and restrictions were placed about the railroad operation with the result that it became more and more difficult to provide service for the rapidly growing needs of the country. By 1914 it had become almost impossible to successfully finance railroad projects. On account of the increasing difficulty of regulating the many companies, all of unequal strength and earning ability, the need of a change in public policy was recognized, and Congress began a most comprehensive study of the transportation problem in 1915. There was also a growing cry for solving the problem by resorting to government ownership and operation. The intervention of the war, which resulted in taking over the railroads by the government as a war measure, at the end of 1917, and operating them under government direction until March, 1920, gave an opportunity to observe and experience government operation of railroads without actual purchase or lease as an economic proposition in peace times. The result of this period of so-called federal control was an almost universal demand that the roads be returned to private operation. After a continuation of the study which was begun before the war and after the most careful study ever given the subject, a new law called "The Transportation Act 1920" was passed and became effective March 1, 1920. Since then the railroads have operated according to its provisions. This marks what might be called the third epoch in railroad regulation.

The Transportation Act, 1920

There were many things about this law which did not suit the railroad managements, but it contains some fundamental provision which should appeal to all fair-minded people and should be considered before condemning it.

Probably the most important of these is that which makes it the affirmative duty of the Interstate Commerce Commission to fix rates which will enable the railroads as a whole or in territorial groups to earn a fair return upon the value of their properties used for transportation purposes. This provision has been seized upon by many critics who say it constitutes a guaranty of earnings to the railroads. It is likely that in the routine of your work, as well as in your social and civic relationships outside of office hours, the most common complaint you encounter is that the government guarantees the earnings of the railroads. Perhaps the most conclusive brief answer to this criticism is that since the law has become effective the railroads have fallen very far short of earning what the Interstate Commerce Commission fixed as a fair return upon the value of their properties, and if there is in fact a guaranty of earnings, the government owes the railroads a huge sum of money. No railroad company has ever claimed that the government owed it anything on account of this alleged guaranty and when it comes to this point even the most rampant radical does not admit the debt on the part of the government.

It has always been the duty of the Interstate Commerce Commission to permit the railroads to charge high enough rates to pay their operating expenses and, in addition, to allow a fair return upon the value of the property used for transportation purposes. It would be contrary to the Constitution of the United States to undertake to compel the railroads to furnish service at less remunerative rates. During the past 20 years, however, it has become so commonly the accepted province of regulatory bodies to consider only rate reductions without regard to consequences, that some such provision as the Tranportation Act contains seems necessary to arrest this mistaken tendency. Recognition of the fact that it is in the real public interest to give the railroads sufficient return to insure an adequate service is one of the outstanding features of the Transportation Act. The provision that rates which will make it possible for the railroads as a whole or by groups to earn a fair return upon the value of their property does not apply to any one railroad and if any railroad fails to make such earnings it has no recourse whatever. On the other hand, if any single railroad should earn more than a fair return, the law provides that it shall pay one-half of such excess to the government.

Almost inseparably linked with the charge of guaranty is that of overcapitalization, or watered stock. It is claimed that the valuation upon which the railroads are entitled to earn a fair return is more than they are worth. For many years prior to 1913 it was the cry of railroad critics that a physical valuation of the railroads would disclose gross overcapitalization. Under the leadership of Senator La Follette a law was passed in 1913 which directed the Interstate Commerce Commission to make such a valuation. Accordingly the Interstate Commerce Commission has been at work for the past nine years and its valuation of the railroads is now nearing completion, approximately $90,000,000 having been expended on this work. The result shows that the railroads are not overcapitalized, but are undercapitalized. The practice followed on most railroads for many years past has been to "plow" back into the property large amounts each year without capitalizing them. The result of this practice has been to more than offset any stock that was issued originally without being paid for at par.

Seeking a new line of attack, it is now claimed that the physical valuation is not a proper test, but that the railroads are worth what they are selling for on the market. There are a great many reasons why this is not a proper means of determining the value of the railroads. It is necessary only to point out a few of these reasons.

One is the assumption that the price at which an almost infinitesimal percentage of the bonds and shares of stock may change hands on the stock exchange is a fair index of the price at which all the stocks and bonds could be bought and sold. The shares of stock and the bonds bought and sold on the stock exchange will be found to represent an exceedingly small percentage of the total, because the great bulk of the stocks and bonds are held by persons who are not trying to sell them and who are not tempted to sell them by the prices which are offered.

*Address delivered at the annual convention of the American Association of Railroad Ticket Agents.

Private Ownership and Operation Best for Employees and Public

Notwithstanding the fact that government operation of the railroads during the war was unsatisfactory because of poor service and high costs, there are some who now advocate government ownership and operation for the railroads. Others who do not advocate it directly, but who propose arbitrary lowering of the rates are aiding in the move to bring it about, because such action would tend to make the continuation of private operation impossible. Prominent among those who are hostile to private ownership and management are some labor leaders and public men who hold out to their constituents higher wages on one hand and lower rates on the other hand. The inconsistency of these promises is apparent to anyone who gives it thought. There is no warrant in the experience of government operation of railroads in this country or in any other country that the expected results would come to either class. There is every reason to believe both classes would be disappointed.

Besides actual figures showing that wages have been higher under private operation since the end of federal control than they were during the so-called federal control period, the further general fact that in times of peace government service is not particularly remunerative, nor especially desirable from the standpoint of rules and working conditions, is evidenced in the familiar cases of the employees of the post office department and railway mail service. It is a far safer and saner policy for the conscientious railroad employee who desires to be secure in his employment and sure of recognition for his ability and for service well rendered to advance in every possible way the interests of the company for which he works, so that the success of private operation will be assured and so that the company will have the ability as well as the desire to give him material consideration. The opportunity for advancement and improvement of men like yourselves who are possessed of a high order of personal initiative and whose duties require the development, to a high degree, of courtesy to the patrons, loyalty to the companies for whom you work—in short, of salesmanship ability—will certainly be much greater under private operation which will preserve competition than under government operation which would eliminate it. The public has a right to and does demand these things which it can get only with private operation.

Politicians who advocate government control are not specific in the advantages they hold out to the public, but it must be inferred that they expect great reductions in rates would follow. If we take into consideration the large deficit which was incurred and also the taxes which are paid by the railroads and compare the net amount that the public paid for its railroad transportation in the last six months of government operation, which ended on March 1, 1920, and the last strictly comparable period for which we have statistics, namely, the period of six months ending March 1, 1923, we find that the cost for the six months of federal control was $3,118,000,000, while for the six months of private control it was $2,883,000,000, or a saving of $235,000,000 under private management, although during the period of private operation the railroads handled a larger business than they did during the six months of government operation referred to.

We are, then, confronted by two surprising facts of great importance. One of these is that it is represented to the railroad employees that they are being paid lower wages under private management than were paid under government management, when the fact is they are being paid higher wages. The other is that representations are being made to the public that it is paying less for it than it did during the closing months of government operation. The question naturally will be raised as to how it is possible for the railroads to pay a higher average wage than they did under government operation and at the same time charge the public relatively less for its transportation service. The answer is that the railroads are being more economically operated and that the net return upon the value of the railroad properties being used for transportation purposes is inadequate. In other words, private operation is now being carried on to the very great advantage of the public and the employees, but at considerable sacrifice to the owners.

From the standpoint of the public, there are many other serious objections to government ownership besides the fact that the cost of transportation would be higher than it is under private operation. One is the large public debt that would be created in making the purchase; another is that the same high standard of service could not be expected; and another that the management of the railroads would become political issues resulting in inefficiency, extravagance, and local favoritism. To keep abreast of the growing needs of the country not much less than one billion dollars annually needs to be spent on the railroads for several years. To raise this sum annually would mean a huge burden of taxation and to determine the manner and places in which it will be spent inescapably would lead to political maneuvering on a vast scale. Doubtless these disadvantages are recognized by the public generally as many of them developed during the short period of federal control. Doubtless they had impressed themselves upon the public mind causing public opinion to declare so strongly against government ownership and operation in 1920.

Freedom from Hampering Legislation Needed

The question after all is how to insure the public that the railroad system of the country will be able to give the greatest amount of service when needed and at the minimum cost consistent with safety. The so-called "service at cost" system offers the most than can be had, but two things should be considered in this connection: First, since the service is to be obtained at cost every effort should be made to leave the railroad managements unhampered in their business so they may reduce their costs and thus the transportation bill of the public; and, second, there must be included in the cost a fair revenue for the use of the railroad property. It is not inconsistent with the intent of the Transportation Act to give consideration to both of these things in administering railroad regulation under that law. There has been and is, however, a strong tendency towards the enactment of laws which will tend greatly to increase the cost of operating the railroads, and thus far since 1920 the net revenues which the railroads have been permitted to earn have fallen far short of returning a fair revenue upon the values of the properties.

Under the existing conditions, the managements of the railroads representing the owners are showing rare courage and rare faith in the ultimate fairness of the American public by continuing to make further enlargements and improvements to their properties so that better service may be rendered at still lower cost. With the co-operation of the employees and the natural growth of this great country, they believe that their conditions will improve steadily until the entire success and superiority of private operation with government regulation will be fully realized. The one and only sure way for the public to help reduce the transportation bill of the country is to help the railroads produce transportation cheaper. The greatest aid to the accomplishment of this, aside from the loyal devotion of the great mass of railroad employees, is freedom from further restrictive and inhibitory legislation, and more liberal administration of the present laws which regulate and govern transportation.

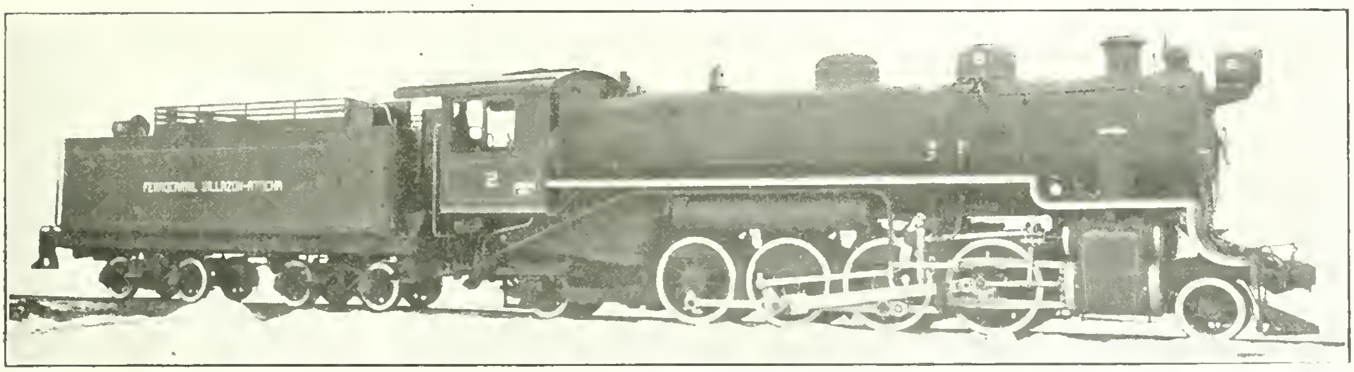
The Atocha-Villazon Railway of South America

New Trans-Continental Line Being Constructed and Financed by American Companies

A new epoch for the commercial intercourse between the countries of Bolivia and Argentine will be inaugurated when in 1925 the railroad now under construction will form the connecting link in a second trans-continental route across South America. The new line is being built between Atocha, the southern terminus of the F. C. de Bolivia, and La Quiaca, the northern terminus of the F. C. Central Norte Argentino.

The construction will span a gap of 198 kilometers, opening direct rail communication between Bolivia, northern Chile, southern Peru and the East Coast. The nearest seaports on the trans-continental route are Buenos Aires and Antofagasta, a distance of 2,340 kilometers.

The primary object of the Atocha-Villazon Railway is to give Bolivia an additional rail outlet. She now has communication with the Peruvian port of Mallendo, and with the Chilean ports of Africa and Antofagasta. The new railway, providing a fourth line into the country, and placing Bolivia in direct access to the east coast of the continent, undoubtedly will be of great benefit, both commercially and strategically, to this rich inland country. La Paz will be but three and one-half days from Buenos Aires, less than three days from the port of Santa Fe, and but three weeks from European ports. In addition the new line will open the shortest practicable route between New York and Buenos Aires, the distance via the Panama Canal, Antofagasta and Bolivia being approximately 450 miles less than by steamship route in the Atlantic.



Heavy Narrow-Gauge Mikado Type Locomotive for the Atocha-Villazon Railway—Built by the American Locomotive Company

Route

The general direction of the Atocha-Villazon Railway is slightly east of south. Between Atocha (km.0) and Tupiza, the principal town and the half-way point on the line, the location follows consecutively the Allita, Chorro and Chalviri water courses. The latter two are precipitous canyons, and this section of the line involves 70 kilometers of construction ranging from "heavy" to work of the most difficult nature.

Following the Chalviri and Talina river valleys south from Tupiza, there are some 26 kilometers of similar, although considerably lighter, construction,—to the village of Nazareno; thence, a steady, heavy ascent of 600 meters to the "alto-plano," and 50 kilometers of location over this rolling table-land into La Quiaca (km. 197.8). Villazon, on the Bolivian side of the border, is km. 195.7.

The entire line lies between 2,794 and 4,058 meters in altitude (9,200 to 13,300 feet). Excepting the attractive valley lands, of comparatively slight extent, adjacent to Tupiza and Nazareno, the route is through a virtual agricultural waste, although there are many mineral deposits in the region.

Progress of Work

In the Villazon-Tupiza section there are 79 km. of dams and artificial works completed; 22 under construction, 18 covered with rails. In the Tupiza-Atocha section, 34 Km. of dams and artificial works completed, 9 under construction, and 24 covered with rails. Each section is employing about 1,000 men on this work. The rolling stock at present, comprises two large locomotives of 140 tons each built by the American Locomotive Company; 15 flat cars, with an additional 20 expected daily. The remaining stock will be ordered within a short time.

It is reported that at the end of 1923 the Villazon-Tupiza section will be ready for public traffic. The Tupiza-Atocha section will have its rails at the end of 1924 and at the beginning of 1925 it is expected that the Argentine-Bolivia Railroad Systems will be linked together.

The construction on the Bolivia side is being handled by the Ulen Contracting Corporation of New York, under the supervision of Mr. Fred T. Hoit, General Manager and J. B. Cameron, Construction Superintendent and Chief Engineer.

The Tupiza-Villazon section is under construction by sub-contract to Lavenas, Poli and Cia., who, under a former contract, had assumed charge of this part of the road in 1920, but were forced to suspend operations owing to the lack of funds.

Financing the Construction

Although the new line has been under consideration by the Bolivian Government for many years and the advantages to be derived, both by Bolivia and Argentine, have long been recognized. But the difficult nature of the country traversed, and the consequent high cost involved, have until recently forestalled the adoption of a comprehensive project for construction, although a certain amount of work had been previously performed. The foregoing was the status of the project when on July 8, 1921, the Bolivian Government contracted with the Ulen Contracting Corporation of New York for the financing and construction of the entire line. A bond issue of up to $10,000,000 U. S. gold was authorized for the work.

Grades

The maximum grade is fixed at 3 per cent compensated; the minimum radius of curvature at 104.3 metrs (11°), excepting in the Chorro canyon where a radius of 82.0 meters (14°) is employed. These standards conform with those already adopted for the partly completed Tupiza-Villazon section of the line, as well as with those of the F. C. de Bolivia in the division terminating at Atocha.

Track Characteristics

The line will be one-meter gauge, the Bolivian standard, laid with 60-lb. rails. Quebracho ties, 1,500 per kilometer, will be used on track-laying from the south, and Douglas Fir, 1,800 ties per kilometer, on the line from the north; 200 additional ties per kilometer being specified for curves of 4° or sharper. Screw spikes are to be used exclusively. Approximately 1.20 cubic meters of ballast, the best locally available, is required per lineal meter.

The principal opening on the line is located at Km. 106, crossing the Rio Talina, where four twenty-meter steel girder spans are to be erected.

Within the first 16 kilometers out of Atocha, where building stone is very scarce and it is desired to expedite the track-laying, a number of corrugated pipe culverts are being installed and three creosoted-pile trestles, aggregating 370 meters in length, are under construction. These types of openings have been used in Bolivia previously and the saving in first cost is calculated to more than off-set the depreciation charges.

All structures are designed on the basis of Coopers E-40 loading.

May 1st, 1925, will not only be the date on which the Bolivian Government will celebrate the Centennial of its Independence, but will also signalize the completion of the entire line.

Details of the heavy narrow gauge engine used in the construction and which will later be used in the operation of the line are as follows:

Gauge	3 ft. 3⅜ ins.
Cylinders	21 ins. x 24 ins.
Driving Wheel Diameter	48 ins.
BOILER	
Diameter	65 ins.
Working pressure	170 lbs.
Fuel	Soft coal or wood
FIREBOX	
Length	81 3/16 ins.
Width	63¼ ins.
TUBES	
Diameter	5⅜ ins. x 2 ins.
Number	150
Length	17 ft. 6 ins.
HEATING SURFACE	
Firebox	134 sq. ft.
Tubes	1367 sq. ft.
Firebrick tubes	21 sq. ft.
Total	2208 sq. ft.
Superheater	591 sq. ft.
Grate area	35.6 sq. ft.
WHEEL BASE	
Driving	13 ft. 6 ins.
Total engine	29 ft. 8 ins.
Total engine and tender	59 ft. 0 ins.
WEIGHT	
In Working Order	
On driving wheels	124,500 lb.
On truck, front	18,000 lb.
On truck, back	21,500 lb.
Total engine	164,000 lb.
TENDER	
Wheels, number	8
Weight	117,500 lb.
Tank capacity	6,600 U. S. gal.
Fuel capacity	8.8 tons
Tractive force	31,900 lb.

Standardized Colors for Signal and Other Glasses

How the American glass industry has helped the railroads of this country to lessen their yearly toll of wrecks and accidents is described by Eugene C. Sullivan, vice-president of the Corning Glass Works, in an article recently issued by the Engineering Foundation, an organization established by Ambrose Swasey of Cleveland to promote engineering and scientific research.

"Time was when each railroad had its own signal colors," says Mr. Sullivan, "greens ranging from blue-green to yellow-chrome-green, yellows from reddish-yellow to green-yellow not far removed from some of the yellow greens. About 1900 there were thirty-two different shades of green used in American railway systems.

"At least one glass manufacturer carried a dozen or more sizes and styles of lens in each of these thirty-two shades. The situation was similar for other colors.

"To correct this dangerous confusion, the glass-making chemist called to his assistance the physicist and the physiological psychologist. After years of collaboration, there resulted for each color a universally adopted hue which affords maximum light transmission and maximum distinctiveness. The standard green, for instance, gives more light than other greens, and is less likely to be mistaken for yellow or blue.

"An American glass-maker discovered that selenium could be made to produce a clear red of almost any depth, with the great advantage for railway signals that it transmits practically all the red rays, and excepting some yellow, nothing else. Other red glasses transmit other parts of the spectrum in addition to red. Selenium is now used universally by American railways for danger signals, and tons of the comparatively rare element are thus consumed annually.

"With the standardization of the green and red in hues which would not be mistaken for yellow it was possible to develop a yellow signal. The introduction of yellow eliminates white or clear as a fixed signal. A white light means broken glass and indicates 'stop.' By re-designing the semaphore lens and employing the high transmission colors, the intensity of the color signal has been greatly increased.

"American glass-makers also introduced the low-expansion heat-resisting glass for railway lantern globes. A trainman's lantern is not unlikely to rest tilted on a brake ratchet or broom handle with the flame playing directly against the glass. Suddenly the lantern is carried out into the rain or snow, the overheated glass breaks, and the signal fails, jeopardizing life.

"For thin-walled chimneys a glass of low expansion had been successfully used abroad. It did not, however, meet satisfactorily the severe conditions to which the thick-walled railroad lantern globe was subjected. A glass was developed in this country lower in expansion than any previously made in commercial quantities. These low expansion globes, both colorless and colored, are safe, and are practically the only ones now in use."

The Work of the Traveling Engineer

Committee Report to the Traveling Engineers' Association

The Committee of the Traveling Engineers' Association appointed to prepare a paper on "How can the work of the Traveling Engineer be made more effective, and can the usual number of Traveling Engineers properly take care of the duties expected of them?" submitted the following as their ideas on the subject under consideration.

In presenting this paper, the members of the Committee realize that this is a subject of importance and their task is not a light one, for numerous reasons. Let it suffice to mention only a few of these reasons at this time. First, we are not writing about the work or merits of a machine, but about the work and merits of men who are following the same line of work as we, some of whom will, no doubt, differ with us in our views on the subject. Again, some of our superior officers may differ with us in our opinions; for we know of no position of which there is a greater difference of opinion than regarding the qualifications and duties of the Traveling Engineer.

When the writer was a novice in this business he read an article defining the qualifications and duties of a Traveling Engineer, and, flatter himself as he would, he could not make himself believe he was qualified for or able to do justice to the position, and had it not been for the good-will and fatherly advice of a superior official, would have given up the office. We realize that a Traveling Engineer's knowledge of his work and duties is a big asset towards making his work effective—still we do not believe he must be a past master in all that pertains to a locomotive and be a superman or one entitled to appear as a "Who's Who," as the article referred to would convey.

We believe a Traveling Engineer's personality and the way he deals with the men under his direct supervision, also with the officers and associates in his work, has a material effect on results obtained, such as being a man whose name carries weight with both officers and men, one having the courage of his convictions to say "Yes" or "No" as the case may require, not given to seeking for petty things to criticise, yet not allowing careless and indifferent work or violation of rules to go unnoticed, but in handling such always be fair, impressing on the offender that you have no enemies to punish or friends to reward when these questions are involved. He should cultivate the faculty of seeing both sides to every question, controlling his temper and getting along with all kinds of men, remembering that much of his success lies within himself. He should shun "gum shoeing" or playing the part of a "Hawkshaw," as there is nothing that will cause his men to lose confidence in him and consequently lessen the results of his endeavor quicker than such as this.

The position of Traveling Engineer is what the name implies; that is, one who travels or puts in the major portion of his time riding on the engines with the engineers and firemen for the purpose of learning the condition of the engines and how they are being handled by the engineers and firemen, it being understood that his training has been such that he is a competent critic on the condition of an engine and the work of the engineer and fireman.

In order that his work may be effective he should know the different parts of the locomotive, the duties of each and how they function, the best methods to pursue in the care and handling of the locomotive, not only when it is in good condition and working perfectly, but when in an imperfect or defective condition. The saying that "a locomotive has a language of its own," is quite true, and to handle engines successfully the Traveling Engineer must know their language so he can tell not only when they are well and doing fine, but also when they are ill and having trouble. The same thing applies to his knowledge of the work and skill of the engineer and fireman. The Traveling Engineer should have been a successful fireman and engineer, so that he can see at a glance whether the fireman and engineer are doing their work right or wrong, being capable to teach and, if necessary, demonstrate to them the best methods to practice. Professionally speaking, he is a physician for both the engine and engine crews, diagnosing, prescribing and administering to either whenever in his judgment such is necessary or required. In fact, we feel he is more like the Chinese doctors we read about who are paid to keep their patients well instead of curing them after they have become ill.

Although the railroads purchase several thousand different articles and commodities and have thousands of employes to carry on their business, they have but one commodity to sell and that is TRANSPORTATION. We say the most important single unit or link involved in the handling of transportation is locomotives—in fact, they are the lifeblood of the railroads and the kind of service they render is measured by two things; i. e., their condition and the way they are handled by the engine crews. Therefore your committee believes the best methods which the Traveling Engineer can follow to make his work more effective is to put in the greater portion of his time riding on the engines with the engine crews under his jurisdiction, seeing that the engineer handles the engine in such a way that he will make the schedules and pull the tonnage with the least possible amount of steam and effort on the part of the engine, thereby saving not only the wear and tear on the locomotive, but also the fuel, which is such a large item of expense to the railroads. He should also see to it that the engineer knows how to make an intelligent report covering defects on the engine, and does it; that the fireman maintains as light and even a fire in the fire-box as is consistent with the work the engine has to perform, maintaining a uniform steam pressure as close to the maximum as possible, when such is required, and avoiding any waste of steam through the safety valves.

By following up his work in this way he can keep in such close touch with his power that defective conditions which cause fuel losses and are detrimental to good locomotive operation can be detected and handled for correction before they become serious. Also, when he has young and inexperienced engineers and fireman he is in the right place to learn how they are doing their work and put them right when such is necessary.

The Traveling Engineer should use his best ingenuity to instill a spirit of honest endeavor in the enginemen so they will use the engines, fuel, tools and supplies in their care as though they purchased them themselves; for, after all is said and done, the success or failure of his efforts depend very much not only upon his own mental attitude, but upon that of his enginemen and upon the support he gets from his Master Mechanic as well as the co-operation of the Roundhouse Foreman. On the other hand, if his superiors have him doing part of every man's work, from the call boy to the Master Mechanic and Superintendent, and holding investigations of all delays, failures and "what-nots," staying in terminals in order to instruct flue-borers, fire-builders and others connected with the handling of engines as to the proper way of handling their work, as well as taking up his time in having him to ascertain and see that work reported by the engineers and himself is not neglected until a failure is caused, he cannot do justice to his work, for he will not then have time to ride each and every engine on his division, at least a short distance every thirty or forty days, nor to instruct such of his enginemen as need close supervision, which is necessary for his work to be effective and get desired results.

From the foregoing we do not want to be understood as advocating that the Traveling Engineer should put in all of his time on the road and none at the shops, roundhouse or terminals, and assisting at investigations. When an engine fails for steam or fails to make the time and handle the tonnage, and the engine is not found to be defective—when handling calls for an investigation and where damage is done on account of rough handling and in cases of emergency, he should hold or attend investigations, as his knowledge gained by long experience and service in the transportation department is of vast importance and value to the Superintendent in many questions involving transportation. The same thing applies to the Master Mechanic, who should consider the Traveling Engineer his trusted assistant, and one to be consulted in many things connected with the successful upkeep and handling of engines; he should see that the recommendations of the Traveling Engineer are given due consideration and that the reported defects are corrected.

Hard work with a demand for good judgment and close figuring in your business are good teachers, all of which the Traveling Engineer has had as fireman and engineer, thereby gaining insight into many angles of the railroad game and making his position valuable, as is demonstrated day by day.

As a final analysis of the subject, your committee wants to call on your imagination, asking you to picture, if you will, what transportation means to business and our country in general, and imagine, if you can, what part the locomotive has and is now playing in the development, maintenance and prosperity of each and as the locomotive is making money only when moving cars or conducting transportation, what effect has the condition and handling of them on transportation. All of you are probably familiar with the following story, which, we believe, can be used here in a small way as an example of the worth and importance of the Traveling Engineer. A freight train had stalled on the hill and the conductor went forward and asked the engineer what was wrong with the engine; he answered that she was all right, hot and never slipped a turn, so it must be too much tonnage. The conductor then said that the yardmaster had told him that the train was 100 tons light. The engineer's reply to him was: "The yardmaster may fool you and you may fool me, but all of us cannot fool this hog." An engineer or fireman or both may fool the Superintendent, Master Mechanic, Train Master and Roundhouse Foreman about the condition of an engine and tell them why they could not pull the tonnage or make the time and possibly many other things about an engine, but they cannot fool the Traveling Engineer. Therefore your Committee feels that if he is allowed to follow up his work as we recommend and is given the authority which the position deserves and the support of his superiors, his services will be most effective; but if not recognized and handled as stated, the usual number of Traveling Engineers cannot properly take care of the duties expected of them. The committee consisted of Messrs. J. D. Heyburn, Chairman; J. J. Rossiter, J. T. Sullivan, B. J. Feeny, W. E. Preston.

A Gasoline Switching Locomotive

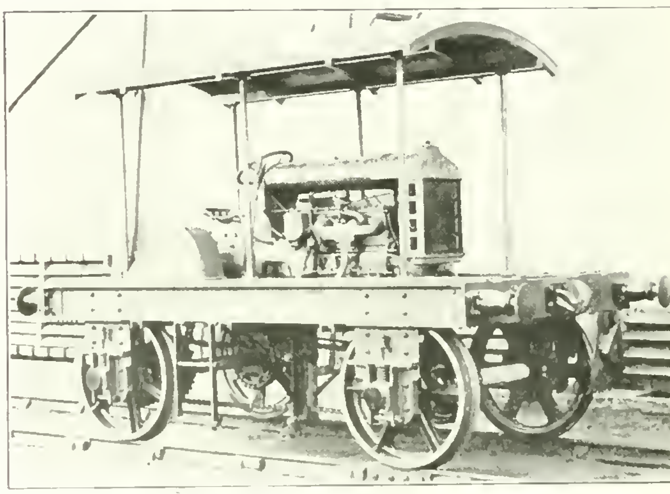
A gasoline locomotive similar to the one here shown was first built for switching purposes for their own use by Lake & Elliot of Braintree, England. It was so successful and attracted so much attention that the company decided to enter upon the manufacture of the locomotive commercially.

As will be seen from the illustration the chassis or body of the car is designed on railway engineering principles so as to provide the necessary weight for traction purposes and to give facilities. On it there is mounted a Fordson tractor motor, large numbers of which are in service.

The power unit has received tests over long periods in the hands of both skilled and unskilled users, and repair facilities and renewal parts are available everywhere.

The shaft of the motor runs back beneath the seat of the driver, to a gear box where the speed is reduced to the proper one for driving the car.

The motor provides for three speeds for forward motion and one for the reverse; but it has been found in practice that the low speed is amply sufficient for



Gasoline Switching Engine—Fordson Tractor Motor

switching purposes and that it is not desirable to use the higher. So that the locomotive may be regarded as possessing one speed for both forward and backward movements.

The drive is by means of chains. The first runs down from the transverse driving shaft located above the floor of the car, to a sprocket wheel on the rear axle. Then from there the drive goes to the forward axle, so that both axles are used for driving after the manner of the old Killingworth engine of Stephenson of a hundred odd years ago.

The car is of the standard gauge of 4 ft. 8½ in. weighs 5 tons; has a hauling capacity of 100 tons and uses about 1¼ gallons of gasoline per hour.

The car is so designed that the motor can be applied at any place.

It is of such a simple form that it can be easily built and equipped.

There are numerous switching jobs and some short branch line work, now handled by a steam locomotive with a full crew, that could easily be taken care of with such an engine, thus effecting a considerable saving in first cost, operating expenses and maintenance.

The engine costs about $2,000.00 complete and can be handled by one man.

Car Pooling on the Pennsylvania

Its Origin and Effect on Cost of Repairs and Facilitating Transportation

By GEO. L. FOWLER

Closely associated with the development of the freight car was the initiation of what is known as the Freight Car Pool on the Pennsylvania Lines.

While the interchange rules of the Master Car Builders' Association had, as their ultimate aim, the facilitation of handling and interchange of traffic between the railroad companies they involved so many complications and inter-responsibilities, that, for the protection of their own lines, the inspectors at points of interchange, were very careful not to pass a car that could, by any possible chance, involve their respective companies in expense. The result was that the cars were thrown back on the delivering roads in large numbers for repairs and defects that did not in the least impair their safety.

The community of interest of the several roads composing the Pennsylvania system, suggested to Mr. Theodore N. Ely, who was at that time superintendent of motive power at Altoona, as far back as 1889 that it was absurd to delay and congest traffic solely for the sake of a series of accounts, which when all was said and done, were mere items on the same balance sheet. Why not bring all of these accounts together, and pool the interests? The principal thing that he had in mind was to secure a freer interchange of cars between the different divisions, and for that reason alone felt that a car pool was necessary. On the principle that any car on the Pennsylvania system should be used as freely in one place as in another and should pass freely from one division to the other, and that it should be repaired wherever repairs were necessary, whether they were slight or extraordinary. This made it necessary to adopt some system of accounting and required on the part of the different departments, the freight repair department, of the different parts of the road, a perfectly honest treatment of the cost of repairs. For several years he urged and urged the point, and worked upon the development of a scheme that would equitably distribute the cost of maintenance among the different properties, and would not demoralize the accounts; that would make an accurate determination of the costs of each property possible, and would show what each was doing. It was a slow process, because each management was afraid of charges that might possibly cut down the annual balance. Finally, however, after two years of effort a meeting was held at the Cresson House July 8, 1891, at which Mr. Ely presided and where a plan was adopted for the distribution of the charges for the repairs of freight cars running over the lines of the system.

The general outline of the method adopted is that all cars belonging to any road of the pool shall be repaired whenever it shall be found necessary. That all costs for labor and material shall be charged to a pool account, and that the grand total, thus formed, shall be charged to the several roads of the pool in proportion to their car mileage. In short, the cost of car repairs to any road is proportional to its car mileage and not to the number of cars owned.

Then, that there might be an approximate equalization of costs at the various shops, Mr. Ely took the arbitrary authority as chairman of the pool, to send a committee around to the several shops to see that the practice of each was good as compared with the others, that the cost in no one shop was too high, and ascertain where more tools or better facilities were needed. The result was a general uplift in the standardizing of the methods of doing the work that cheapened the cost. It was, naturally a matter of very great importance as the expenditure amounted to thirty or forty millions of dollars covering as it did, the maintenance of about two hundred and fifty thousand freight cars.

No car rental, per diem or demurrage is paid by one road to another but each road is paid interest at 4½ per cent on its investment in cars. The valuation of this investment was originally based on the depreciation scale in force in the rules of the Master Car Builders' Association at the time of the formation of the pool and since then the basis is the amount paid for new equipment. The interest is paid by an assessment on each road pro rata on the basis of the car mileage. Demurrage collected at terminals is a credit to the pool which the roads share on the car mileage basis. Where repairs are made to foreign cars, the cost is charged to the pool and a credit given to the same for the amount of the bill rendered to the foreign road.

The handling of these costs is managed by a so-called clearing house although it only requires the service of one man, and each road sends to him a statement of the amount expended by it each month, and he obtains the total freight mileage made by each from the car record office.

The result of many years' experience with this method of freight car repairs and accounting is that it is regarded by the officers of the system as a great benefit in the simplification of accounts and directly contributing to greatly facilitating the traffic. Cars are inspected between the lines for safety only. It is immaterial where they are repaired. The condition of maintenance has been raised to a much higher standard than it was before, because, under the pool, each road has an interest in keeping every car in the pool in a high condition of efficiency, which was not the case before The result is, that a uniform standard of maintenance can be held, and each road has an individual interest in living up to it.

In the matter of renewals the pool cars are divided into classes: those ten years old or more and those less than ten years old. Each year the pool purchases a certain number of cars and distributes them among the roads pro rated according to the old or obsolete cars owned, in order to maintain the pool in an efficient condition, and this permits the destruction of a corresponding number of such cars. For increase of equipment each road acts for itself, and by the purchase of new cars merely adds to the sum of its investment and the interest with which it is to be credited.

The per diem charges made against foreign roads for the use of the pool cars, and the payments made for the use of foreign cars are credits and debits to the pool, when each road shares or carries in proportion to its own mileage. In brief the whole system of cost charges is based upon car mileage, or the use which is made of the rolling stock, with the exception of the rental for use which rests upon the investment. Hence each road pays in proportion to the use which it makes of the pooled cars. For example: if the roads east owned 500 cars and the roads west 100 cars and the mileage of the roads east was two-thirds of the total, they would pay two-thirds of the cost of maintenance, and the roads west one-third, though the latter owned but one sixth of the cars of the pool.

There are, of course, a large number of special rulings bearing upon the details of operation, but the essential principle is that set forth and has not been varied since its adoption in 1891. Its inception and development must be among the things credited to Mr. Ely, and until the time of his retirement the accounts were kept in his office. The method has been so successful on the Pennsylvania lines that it has been adopted on other systems with such variations of detail as local conditions required. But as a broad general principle the interline pooling of freight cars was originated and developed into a working system by Mr. Ely, the well known superintendent of motive power of the Pennsylvania Railroad.

Westinghouse Company Completes Contract for Electrification of Chilean Railway

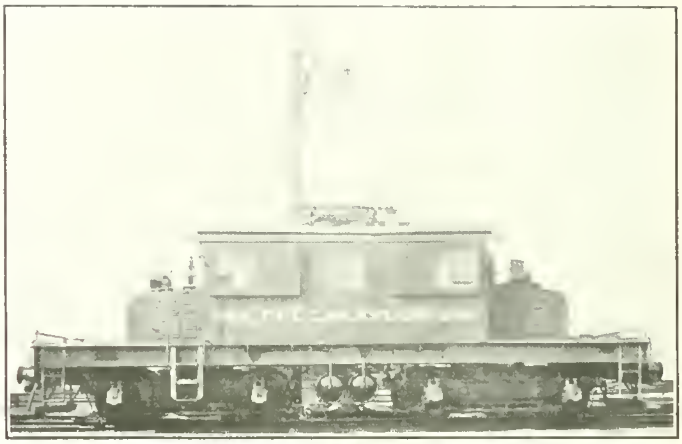
The work of the inspection Commission that has been following the construction of the substation equipment, locomotives and overhead line material through the shops of the Westinghouse Electric & Manufacturing Company for the Chilean State Railways practically ended with the departure of the final shipment of locomotives from the East Pittsburgh works recently. Parts of all three types of locomotives included in the contract constituted the last consignment.

It will be remembered that the contract for the complete electrification program was awarded to the Westinghouse Company in 1921 with several other electrical manufacturing concerns throughout the world offering very keen competition, and represented an expenditure of $7,000,000; the largest amount, at that time, that had ever been appropriated by any railroad in the world for a program of this kind. During the years covered by the period of the World War, fuel costs became so excessive and the traffic of the Chileau State Railways was so rapidly reaching track capacity, that an entirely new source of motive power seemed to the management the only logical and best solution of the embarrassing problem which was fast becoming an acute situation to the republic, the decision to immediately electrify was reached. Later developments have divulged the fact that the electrification of the broad gauge track between Valparaiso and Santiago with the Los Andes branch as covered by the contract, was only the first step toward the adoption of electro-motive power for the entire system of government railways. In the present undertaking 116 miles of main line route and a branch line of 24 miles long will be operated entirely by electric power.

Thirty-nine locomotives—fifteen road freight, six express passengers, eleven local passenger and seven switchers—five complete substations and 140 route miles of overhead line material constitute the equipment required to adequately equip the first zone for electric operation.

Fortunately, the contract for this material was awarded to the Westinghouse Company when industrial activities in the United States were at a very low ebb and they were able to turn all efforts to the construction of the equipment which, alone was to hasten the relief of Chile's railroad troubles by the replacement of steam operation with electric in the shortest possible time. The great speed with which locomotives, substation equipment and overhead line material was hastened across the 5,000 miles of water between United States and Chile is evidenced in the record-breaking shipments coincident with the undertaking. Receiving the order in the fall of 1921, every piece of apparatus was designed in detail and the first shipment enroute to Chile by June of the following year. Thirty-three cars representing a distance of almost a quarter of a mile were required to transport the two complete substation units which constituted the shipment. This attainment in shipping records, however, was shadowed by the second consignment which was featured by an unprecedented feat unparalleled in history—the starting of a train by wireless; three complete substation units required thirty-three cars for overland transportation and the aggregate weight amounted to over 800 tons. The first shipment of locomotives established still another record. Six complete engines all ready for shipment by sea marked the largest single consignment of its kind known to the industry.

The erection of substation buildings, installations of units, erection of overhead lines and transmission circuits, and the final preparation of locomotives for operation, has progressed under the supervision of Errazuriz, Simpson and Company, general contractors of the Chilean State Railways for this project, augmented by several engineering representatives of the Westinghouse Company, who are assisting particularly in the proper assembling and installation of the electrical equipment. Much of the general contracting work has been sublet to concerns specializing in certain phases of erection work. It is expected the project will be finished in the fall of the year.



Electric Locomotive for the Chilean Railways

Regular operation of electric trains was begun early this year between Santiago and Til Til. Two passenger trains made the trip daily between these two points, one leaving Santiago at 11:05 A. M. and arriving in Til Til at 2:00 P. M. The other train known as the "milk train" leaving Yungay, a suburb of Santiago and in the city limits, at 5:00 P. M. remains over night in Til Til, where it gets its load of the dairy products, and passengers enroute, arriving in Santiago at 10:00 A. M. The smoothness and ease of operation and dependability of these trains in handling the traffic is bringing an endless flow of commendation from patrons and officials alike.

Now that the Chilean contract is practically completed, at East Pittsburgh works of the Westinghouse Company, activities will be centered about the construction of locomotives already on order for other important electrified transportation system. These include eight 4,000 horsepower motive power units for the Norfolk and Western Railway extension, and 36-4,000 horsepower motive power units for the Virginian Railway, which forms a part of the recent $15,000,000 contract; twelve for the New York, New Haven and Hartford Railroad, and three for the Pennsylvania Railroad.

Snap Shots—By the Wanderer

From time to time we hear of derailments of locomotives while running backwards. Often the results are fatal and nearly always expensive. If an investigation is made, the result is to clear all hands of responsibility. There was nothing the matter with the mechanism of engine or tender, and "no reason can be assigned for the accident."

There is a possible reason, which may be no reason at all and yet may be reason enough.

It is generally conceded that a switching locomotive puts more lateral stress upon the rails than any other type of locomotive. But it is not generally known that a six-wheeled truck under a passenger car, runs a switching locomotive a close second. The reason is very simple. A switching locomotive has no guiding truck at the front. In other words, it does not have a flexible wheel base. Neither does the six-wheeled truck. The mere fact that it supports one end of a car and that another of the same kind is at the other end, does not make them in the least dependent upon each other. In short, they each act like independent vehicles. Investigation has shown that the lateral thrust put upon the rail by trucks of this kind, are almost invariably higher and sometimes considerably higher than that exerted by any one of the wheels of a Pacific locomotive hauling them.

Further, it has been found that a consolidation locomotive running forward puts very much less stress upon the rail than the same locomotive running backwards. When running forward, the truck exerts the greatest amount of lateral thrust, followed by the second driver. But, when running backward, the whole thrust seems to be concentrated on the rear driver, which delivers a thrust on the outer rail of a curve that is startling in its suddenness and intensity.

As this increases very rapidly with the speed, it would seem to be the part of ordinary precaution to make pretty rigid restrictions as to the speed of consolidation and mogul locomotives when running backwards.

Opinions will probably vary as to what the proper allowable limit of speed should be. Some may think any limit unnecessary, in view of the fact that high speed express engines were run for years in England without a leading truck. But, in view of the facts of the case as they have been developed, it is suggested that no consolidation or mogul locomotive ought to be allowed to run at a speed in excess of 20 miles an hour. Certainly 40 miles an hour, a speed at which an unexplained derailment recently occurred, is too high for safety, and it would almost seem strange if a derailment did not occur at such a speed in view of the measurements that have been made.

I am quite well aware of the danger of harking back to the glorious past and drawing comparisons from it to the detriment of the present. It has been the favorite occupation of greybeards for all generations, and an equally popular source of ridicule and amusement for all whose beards are still untouched by time and live in an unbounded belief in the present and future. But what I shall have to say will be based not only upon recollections but upon survivals of a past that had certain characteristics which we seem to be losing and which bid fair in the course of a few years to become extinct.

As the carp and the duck-billed platipus are relics of the animal life of a very remote past, so we now have a few isolated examples of workmen who have survived and who represent a class, that while not extinct, is fast becoming exceedingly rare. I refer to that type which is known as the New England workman. The workman who had the all around training of his trade and who could turn from one class of work to another with a facility that few today can parallel. Now it is the specialist who holds the center of the stage, the lather, planer or milling machine hand. Even though he may have had preliminary training on all the tools as an apprentice, he soon becomes a special tool hand when he starts as a Journeyman. We would call him a tramp today. But after all, that journeying to and fro on the face of the earth to learn how other men worked in the old days, gave a man a pretty good training in his trade, which he expected to follow and ornament to the end of his days.

Well! Times change. But there is always something of the past that is worth preserving. This seems to be one of those things. That I am not alone in the belief is shown by the offer of certain prizes by the French government. They are to be awarded for excellence in the execution of a piece of work, all parts which must have been made by the contestant. Then, for that example which shall be adjudged the best the maker shall receive the title of the "Best Workman in France." He may show a cabinet of wood or a machine of iron and steel. It may be of any material and for any purpose. Surely the winner would be proud of his title, and would have to be par excellence, what we are pleased to call the all around mechanic.

How the Dollar Came and Went on the Pennsylvania

Last year the Pennsylvania Railroad System received on the average over one and one-tenth cents for hauling a ton of freight one mile and a little over two and eight-tenth cents for hauling a passenger one mile, according to reports compiled at Broad Street Station.

Taking one dollar as representing the total revenues for the year, the reports show the source of each item of revenue and what relation it bears to the Company's total revenues. On this basis, 61.28 cents of every dollar which the Company took in came from the transportation of freight and 23.71 cents came from the passengers.

Other sources of the Company's revenues as analyzed in the reports follow: For the transportation of mail, the Company received 1.43 cents out of the total dollar of revenue; for the transportation of express matter, 2.22 cents; other miscellaneous services which the carrier performed brought in 6.35 cents and income from corporate investments 5.01 cents.

A similar report on the disposition of every dollar received shows that the largest amounts went into three items: train, station and switching operations and other transportation service, 28.97 cents; maintenance of locomotives, freight and passenger cars and other equipment, 21.00 cents; and maintenance of tracks, roadbed, buildings, bridges and other structures, 11.35 cents.

The next largest item of expenditure was 7.71 cents for rental of equipment, joint facilities and miscellaneous rents and income charges. Next came fuel which took 6.96 cents of every dollar received.

Depreciation on equipment took 3.38 cents; loss, damage and casualties 2.21 cents and other miscellaneous items such as pensions, legal expenses, etc., 3.28 cents. Taxes took 4.34 cents; interest on bonds and other interest 5.58 cents, while dividends took only 4.14 cents, being less than the taxes. This left a balance of only 1.18 cents out of each dollar to be expended for enlarging and improving the property and to provide a surplus to create the necessary credit basis.

Shop Kinks

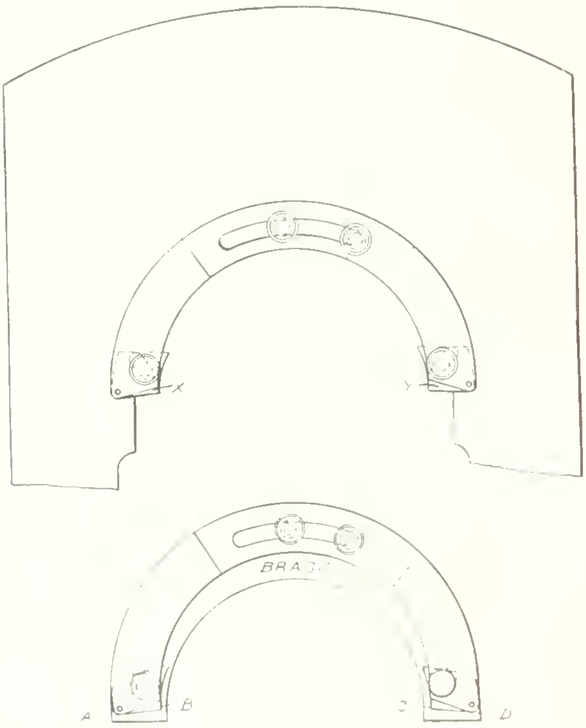
Handy Devices Used in the Shops of the Erie Railroad

Device for Fitting Driving Box Brasses

There is, in the Galion, Ohio, shops an adjustable template that is used for laying out driving box brasses for fitting them to the boxes.

The box is bored out to the proper diameter and with the recessed angles at the ends for holding the brass. The brasses are also turned to the same diameter in the usual way.

The template is made in two parts, held together by bolts. One part is slotted so as to permit of an adjustment of the length of the arc that they cover. At the ends there are the two loose pieces X and Y which are fitted with slotted holes and held in place by small bolts so that they can be adjusted to fit any angle in the box for the seat of the brass.



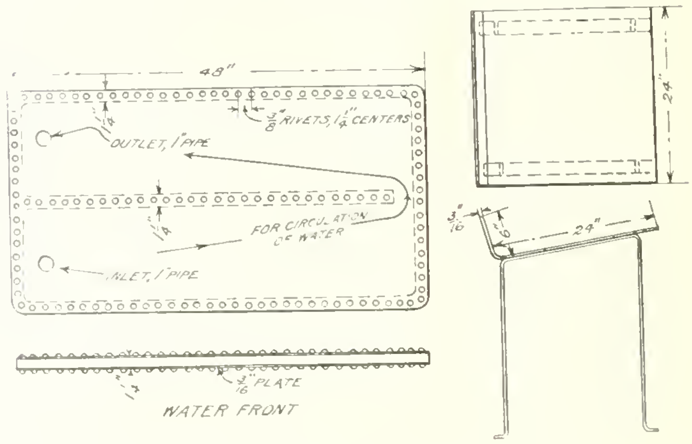
Device for Fitting Driving Box Brasses

The template is inserted in the opening for the brass and the pieces X and Y are adjusted to fit the angles and fastened. It is then laid on the end of the brass and the lines A B and C D scribed thereon. These lines are those to be worked to in the fitting of the brass to the box.

Water Front for Bolt Heating Furnace

This front is one that is in use in the Hornell shop. It is illustrated to show the construction of an efficient front that can well be copied. Too frequently the water front consists either of a sheet of steel cooled by water flowing over its surface, or by a simple thin tank, of the same general form as the one shown, but with merely an inlet on one side and an outlet on the other. Such a front is very apt to have a line of circulation passing through it with hot areas on each side thereof.

As will be seen, this front is 48 in. long over all and has a partition extending out along its center line to within about 2-in. of the further side. The inlet is at one end near the bottom and the outlet directly over it near the top. The cooling water is, therefore, obliged to flow the whole length of the front to the narrow opening at the end of the partition and thence back to the outlet, insuring a circulation over the whole surface of the front with a resultant uniformity of temperature.

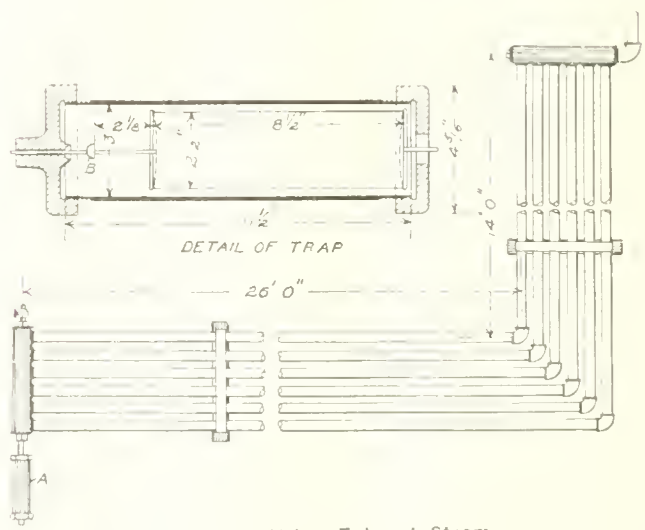


Water Heater Front for Bolt Heating Furnace

Radiator for Using Exhaust Steam

Where exhaust steam is used for heating purposes, the saving usually amounts to the total amount of heat utilized. The old method of doing this was to turn the steam into an ordinary coil of pipe, permitting it to run to the end of it, and then discharging either into the open air or into a barrel; which, as it filled with the water of condensation served as a seal and crude trap for the end of the pipe. This was a method both wasteful and sloppy.

At the Meadville shops, they have designed a coil and



Radiator for Using Exhaust Steam

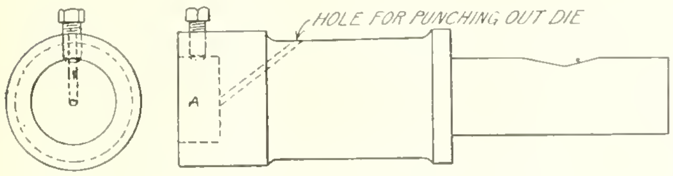
trap which works well and efficiently. The coil or nest is shown in the accompanying engraving, and in its construction the lineal feet of 1½-in. pipe, of which it is made, is limited to 246.

The radiator is preferably made L-shaped with the vertical pipe about half the length of the horizontal and all spaced 3½-in. between centers. The trap, which is shown in detail at the upper portion of the engraving, is shown at *A* attached to the bottom of the branch pipe at the exhaust end of the radiator.

The top of the trap is at the right of the detail engraving, and it is attached to the branch pipe by a pipe nipple of any convenient length, and is suspended as shown. The use of an L-shaped radiator insures a flow of the water of condensation into the trap.

The trap is made of a piece of 3-in. pipe 8½-in. long with a cap at the top which has an opening threaded for the attaching nipple. At the bottom there is a casting having a projecting teat with a hole through it to serve as a guide for the stem of the hollow copper float, a seat for the valve *B* which is attached to the stem, and an outlet for the water of condensation.

When the radiator is empty the weight of the float



Plunger for Ajax Heading Machine

holds the valve *B* down against its seat, as is itself held at a height of 2⅞-in. above the bottom of the trap. When the exhaust steam is turned into the radiator, the water of condensation flows down into the trap and after filling the bottom part lifts the float and so raises the valve from the seat permitting the excess of condensation to escape. The amount of lift of the valve will be sufficient to regulate the flow to the rate of condensation.

If it is desired to drain the trap after the steam has been shut off and there is no more condensation flowing, it can be done by lifting the valve and float by the stem where it projects down through the bottom of the trap.

Plunger for Ajax Heading Machine

This header is one that has been designed at the Hornell shops, its characteristic feature being the hole shown by dotted lines for punching out the die. The die itself is circular in form to fit the hole *A* in the end of the plunger, in which it is held by the set screw at the side.

Chuck for Planing Guides

This chuck is in use in the Susquehanna shops for planing guides. They are made of cast iron and are used in pairs. The bottom is planed with the lugs to suit the planer upon which they are to be used and they are blocked and clamped in place with the usual wedges, straps and bolts. Once set they are in alinement for the work.

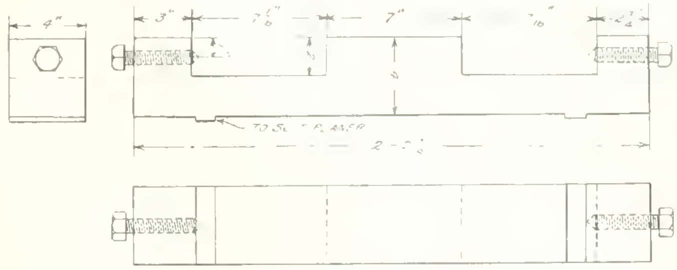
The guides are held in the gaps in the upper face, by the set screws, and when they are held fast against the vertical wall on the opposite side to the set screw they are straight and can be truly finished. Having the chucks counterparts of each other in this way makes it possible to set the work rapidly and accurately and greatly increases the output over the old way of setting each guide independently upon the platen.

Cutting Tool for Tapering Wedge Bolts

At the Meadville shops they are using an Acme bolt pointing machine for tapering wedge bolts. In order to do the work a cutting tool like that shown is employed. It is made of ⅝-in. by 1¼-in. steel ground off with a bottom clearance of 19 degrees and a side clearance of 18 degrees and with no rake. The machine is set and the bolt held for the proper taper, and the cutting is done rapidly and smoothly.

Dies for Making Spring Hanger Gibs

At the Buffalo shops they make spring hanger gibs with punches and dies in two operations, finishing them

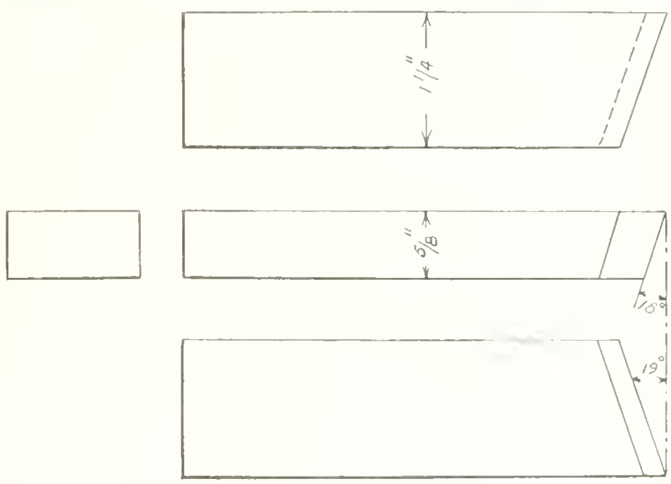


Chuck for Planing Guides

complete from the rough bar and thus greatly reducing the cost of production.

The first operation uses the punch and die of Fig. 1. The punch is of the dimensions given those marked *A* being such as to suit the machine in which the punch is to be placed.

The die has an opening *B* of the same shape as the punch passing all of the way through it. This opening has a clearance of about 1/32-in. all around for the passage of the die. A square hole *C* ⅞-in. by 2⅜-in. passes



Cutting Tool for Tapering Wedge Bolts

through the body of the die at right angles to the punch hole or die proper *B*. This serves for the insertion of the rough bar from which the gib is to be punched.

The body of the die which measures 3¾-in. by 3¼-in. by 6¼-in. is fitted with a handle 1-in. square, whose length *D* may be of any convenient measurement.

In action the punch is entered into the upper half of the die and the bar slipped beneath it. The punch is then brought down, punching the rough gib into the lower half of the die. This part of the work is done as rapidly as the die can be raised, the bar moved and the punch brought down.

The second or finishing part of the operation is done with the die shown in Fig. 2 and is performed under a steam hammer.

The die is made in two halves each being sunk for the reception of one half of the gib, and of the form and dimensions of the finished article. The body of each half is 1¼-in. thick and it is furnished with a handle of any convenient length.

The rough gib as it comes from the punch is heated and laid on the bottom half of the die of Fig. 2. The upper half is laid over it, and a few blows of the hammer causes the metal to flow and fill the die, and the gib is finished.

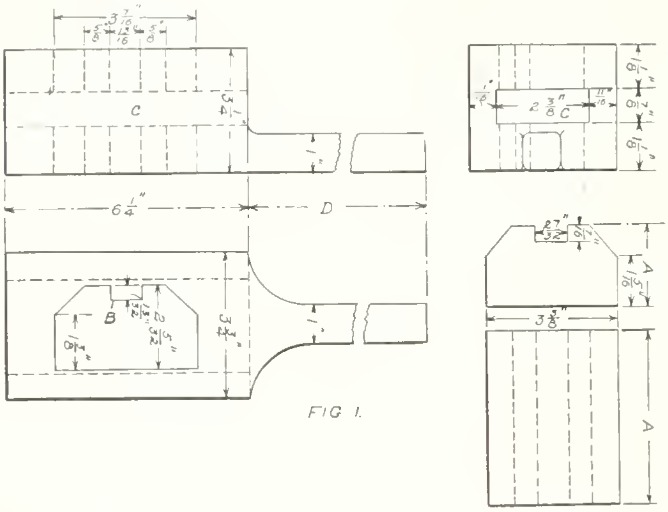


FIG 1.

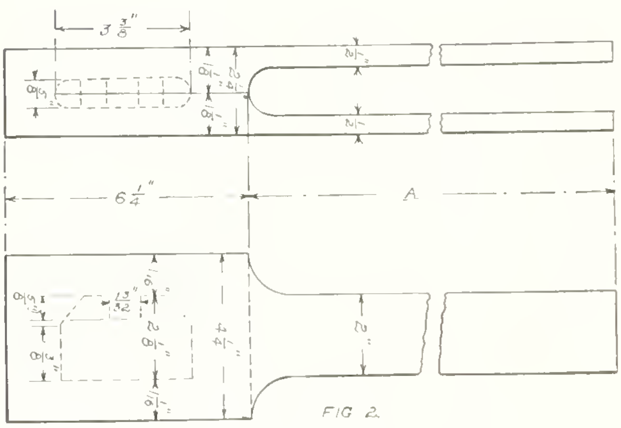


FIG 2.

Dies for Making Spring Hanger Gibs

Air Strainer for Air Pump

The proper and thorough cleansing of the air flowing into the air pump is a necessity if there is to be a proper functioning of the pump itself and the triple valves for which it supplies the air. The arrangement here shown is a very efficient device.

It is formed in the shape of a large oil cup with a thread on its stem to attach it to the pump cylinders. There is a shelf 7/32 in. wide running around the inside of the main cavity at the bottom. A perforated brass plate is soldered on top of this and serves as a support for the hair with which the cavity is filled.

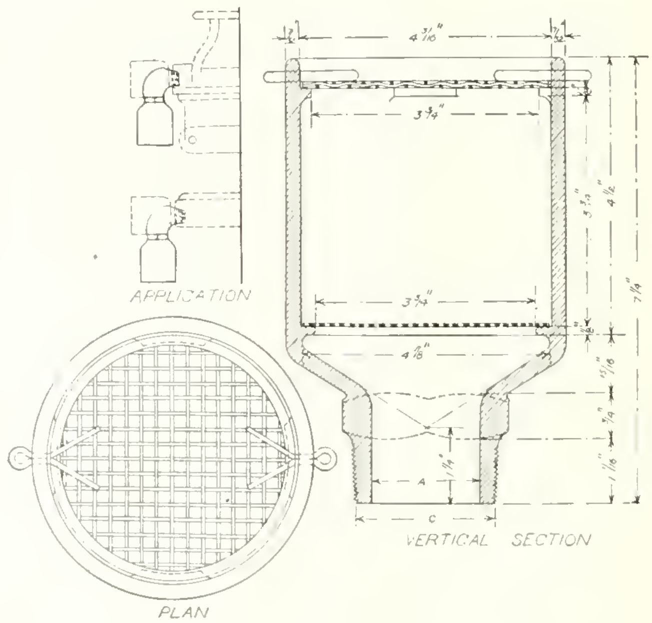
There is a similar shelf at the top on which a wire netting is loosely placed and held in place by the two split keys, as shown.

The space between the netting and the perforated plate is filled with two ounces of the best quality of drawn hair.

Whenever the boiler is to be washed or whenever the locomotive is in the shop for repairs the hair is removed and pulled apart so as to remove the loose dirt, and it is then carefully soaked in carbon oil of 150° fire test. And then before putting the hair back in the strainer, the perforated plate shsould be thoroughly cleaned.

The strainer should be applied to the pump with the opening or netting end turned down as shown in position No. 1. In this a standard Street elbow is to be used; but, where this is impossible on account of clearances, the strainer where the interference occurs may be put in a horizontal position as shown by the dotted lines in position No. 2.

The body of the strainer itself may be of standard size but the thread, hole and hexagon for screwing it into place are of two sizes, for the 9½ in.



Air Strainer for Air Pump

pump and the 8½ in. cross compound pump respectively. The thread as indicated by C is cut for 1½ in. pipe for the 9½ in. pump, and for 2 in. for the 8½ in. cross compound. The hole at A is 1⅝ in. and 1¾ in. in diameter for the two sizes of pumps respectively; and the distance across between the flat faces of the hexagon is 2⅝ in. and 2¾ in. for the 9½ in. and 8½ in. cross compound pumps respectively.

New York Central Night in Brooklyn

"New York Central Lines night" was celebrated by the Traffic Club of the Brooklyn Chamber of Commerce Oct. 19. Addresses were delivered by P. L. Gerhardt, president of the Brooklyn Chamber of Commerce; George H. Ingalls, vice president of the New York Central Lines, and Robert J. Cary, general counsel of the New York Central Lines.

"Transportation, as typified by the New York Central Lines and personified by its officers, is here the honored guest of commerce and industry incarnate in you, members of a great organization of a great city," said Vice President Ingalls.

"For years there have been persistent attempts to further certain political fortunes by professional hostility to railroads. Enough of success has attended these efforts to work vast harm to the country. Development of the railroads was checked and this inevitably slowed down the growth of all other enterprise. Then, just at the darkest hour came the Transportation Act, the first constructive railroad legislation in three decades. Under its provisions the railroads have made a recovery which a year ago seemed impossible.

Proposed New Railways in Chile

A bill calling for the expenditure of considerable sums annually in new railroad construction has recently been approved by the Chilean National Council of State and will shortly be submitted to Congress, according to a report to the Department of Commerce from the Commercial Attache's office in Santiago. It is believed inadvisable to delay longer the construction of lines needed for the development of some of the best agricultural sections of the country.

The bill provides that large deposits be made by the State railway administration during 1923 and 1924, and that preference be given to construction of railroads for which property has been ceded gratuitously or money or materials given by neighboring property owners.

Italian State Railway Operations Improving

The Italian State Railways show greatly improved operating results during the first six months of 1923, compared with the same period of 1922, according to a statement of the High Commissioner of State Railways forwarded to the Department of Commerce by Trade Commissioner A. A. Osborne.

Freight to the amount of 28,592,373 metric tons was carried during the first half of the current year, compared with 24,516,271 tons in 1922. The number of car loadings amounted to 3,022,700 in 1923, compared with 2,598,115 in 1922. The average loading per car was a fraction over 9 tons in both periods.

Despite the increased tonnage of freight handled, the number of train miles decreased 2,173,236 to 24,064,958. Increased switching efficiency was also recorded during the first half of 1923. Gross revenues increased 124,000,000 lire to 1,497,000,000 lire.

3,400,000 People on Public Payroll

There are 3,400,000 on the nation's public payroll employed by either Federal or other governments, whose salaries cost the people of the country $3,800,000,000 a year, according to a statement just issued by the National Industrial Conference Board. That is $91 for every person over 10 years of age gainfully employed. The board, which has been making a study of the rising wave of taxation and its relation to public welfare, bases its figures on reports says in part:

"Exclusive of pensioners there are 2,700,000 public servants on the payroll of national, State and municipal governments. They receive approximately $3,500,000,000 a year in pay. Pensioners and other inactive persons number 670,000, who annually get $320,000,000.

"Further analysis by the National Industrial Conference Board shows the public payroll cost every man, woman and child in the United States $34 a year, nearly one-half the amount paid out in wages by all factories producing more than $5,000 worth of goods in the year 1921."

The recent reports of the Interstate Commerce Commission and the Bureau of Railway Economics show that last year there was an average of 1,697,000 employes on the railroads, who received wages totaling $2,468,000,000. Had Government ownership of American railroads been in effect there would, therefore, have been approximately 5,100,000 persons, or one person out of every eight over 16 years of age, on the public payroll.

Rolling Equipment Placed in Service During Month of September

The railroads during the month of September placed in service 18,519 new freight cars, together with 380 new locomotives. This brought the total number of new freight cars installed from January 1 this year to October 1 up to 134,636, while the number of new locomotives installed during the same period totaled 2,936. The railroads on October 1 also had on order 64,601 new freight cars, with deliveries being made daily. They also had 1,242 new locomotives on order. Of the 18,519 new freight cars installed during the month of September, 8,916 were coal cars, which brought the total number of cars for that class of equipment installed during the first nine months this year up to 55,575. They also installed during September, 6,809 new box cars, making a total of 52,936 placed in service since the first of the year. New refrigerator cars installed during the month totaled 1,405, while 970 new stock cars were also placed in service.

U. S. Locomotive Builders Output

The U. S. Commerce Department reports U. S. locomotive builders' operations as follows: Locomotives shipped from plants in August, 1923, 272, compared with 239 in July, 1923, and 151 in August, 1922. In the first eight months of 1923, 1,916 locomotives were shipped, compared with 641 in the same period in 1922. Unfilled orders on hand at the end of August, 1923, totalled 1,497, compared with 1,738 at the end of July, 1923, and 1,035 at the end of August, 1922.

Notes on Domestic Railroads

Locomotives

The Baltimore & Ohio is in the market for 15 Pacific type locomotives.

The Temiskaming & Northern Ontario is reported to be in the market for 4 Mikado type locomotives.

The Maryland and Pennsylvania contemplates the purchase of a consolidation type locomotive.

The Long Island is reported to have purchased 5 locomotives.

The Pennsylvania Light & Power Company has placed an order with the Baldwin Locomotive Works for a switching engine.

The Southern Pacific has ordered 17, 2-10-2 type and 8 Pacific type locomotives from the Baldwin Locomotive Works and 18 Mountain type locomotives from the American Locomotive Company.

The Missouri Pacific contemplates buying about 60 locomotives.

The Louisville & Nashville contemplates buying about 35 locomotives.

The St. Louis & O'Fallon is inquiring for one Prairie type locomotive.

The Aliquippa & Southern has ordered 1, 0-8-0 type locomotive from the American Locomotive Company.

The Long Island has ordered 5 switching locomotives from the American Locomotive Company.

The Southern Pacific is inquiring for about 60 locomotives as follows: 32, 2-10-2 type locomotives; 8 Pacific type locomotives and 18 Mountain type locomotives. All the above locomotives will use oil for fuel.

The Rutland is considering the purchase of a Pacific type locomotive.

The Harland Railroad is to enter the market for a locomotive.

The Toledo, Angola & Western is considering the purchase of a Mikado type locomotive.

The Louisville, Henderson & St. Louis has under consideration the purchase of two Pacific type locomotives.

The Southern Pacific is inquiring for 20, 0-6-0 switching type locomotives.

Freight Cars

The Chesapeake & Ohio is inquiring for 25 caboose cars.

The Southern Pacific Co. will soon enter the market for 8,730 freight cars.

The Pacific Fruit Express is contemplating the purchase of 5,000 refrigerator cars.

The Baltimore & Ohio has entered the market for 1,500 freight cars.

The Yosemite Valley is inquiring for 50 hopper cars.

The National Railways of Mexico is inquiring for 425 single sheathed box cars.

The Central of Brazil is inquiring for 200 steel gondola cars.

The Chicago, Burlington & Quincy is inquiring for 1,000 gondola cars of 50 ton capacity.

The Chicago & Alton has placed an order with the Pullman Company for 250 gondola cars and has also ordered 350 gondola car bodies from the Ryan Car Company.

The Union Pacific is considering the purchase of a large number of freight cars.

The Norfolk & Western has entered the market for a number of freight cars.

The Great Northern has issued an inquiry for a number of freight cars.

The St. Louis-San Francisco has entered the market for 2,500 refrigerator cars.

The South Australian government is reported to be in the market for 1,200 steel cars including 600 gondolas and 500 box cars.

The Baltimore & Ohio is inquiring for prices on 1,000 gondola cars.

The Minneapolis & St. Louis has ordered repairs to 600 box cars at the shops of the General American Car Company.

The New York, Chicago & St. Louis has ordered 200 steel underframes from the American Car & Foundry Company, and has also ordered 10 underframes for caboose cars from the Pennsylvania Tank Car Company.

The St. Louis Southwestern has issued an inquiry for 150 steel underframes for flat cars.

The Delaware, Lackawanna & Western has placed an order for repairs to 100 box cars with the American Car & Foundry Co.

The Baltimore & Ohio is inquiring for 440 hopper car bodies of 55 tons capacity, and 107 40 ton box car bodies.

The Fruit Growers Express is reported to be in the market for 2,000 steel underframes.

The Ulster & Delaware is inquiring for 10 caboose cars.

The St. Louis, San Francisco is inquiring for 2,500 ventilated refrigerator cars.

The Southern Pacific contemplates coming in the market soon for a large number of freight cars. It is understood that the program calls for the purchase of about 18,000 cars.

The Union Pacific program for new equipment, it is understood, calls for the purchase of several thousand cars.

The Mexican Petroleum Company has placed an order for 100 tank cars of 10,000 gal. capacity with the American Car & Foundry Company.

The Union Pacific is building 25 caboose cars at the Albina Shops, Albina, Ore.

Passenger Cars

The Chesapeake & Ohio has ordered six combination mail and baggage cars from the Pullman Company.

The Interborough Rapid Transit Company is inquiring through the Rapid Transit Subway Construction Company for 100 steel motor cars, with an option on 150 additional cars.

The Southern Pacific is reported to be in the market for 78 electric passenger cars and 74 steam passenger cars.

The Cornwall Railroad is inquiring for a gasoline rail car.

The Erie has placed an order for 2 gasoline motor rail cars with the Service Motor Truck Company, Wabash, Ind.

The Philadelphia & Reading has purchased 40 steel suburban coaches and 10 steel combination coach and baggage cars from the Bethlehem Shipbuilding Corporation.

The Southern Pacific contemplates the purchase of about 125 cars for passenger service.

The New York, Westchester & Boston is considering the purchase of 10 cars for passenger service.

The Long Island has placed an order with the American Car & Foundry Company for 60 steel motor passenger cars.

The Louisville, Henderson & St. Louis is inquiring for three baggage and mail cars, two coaches and two smoking cars.

Buildings and Structures

The New York, Chicago & St. Louis plans the construction [illegible] additions to its shops at Frankfort, Ind., including a new engine house, repair shop, etc.

The Central R. R. of New Jersey is reported to be negotiating for the purchase of property in the westside district of Bethlehem, Pa., for the site of a new engine house and [illegible] shops.

The [illegible] is preparing plans for the complete electrification of the classification yards and service buildings at [illegible], Pa.

The Toledo, St. Louis & Western has awarded a contract to Bierd, Lydon & Grand Pre, Chicago, for the construction of a 27-stall engine house and other engine terminal facilities at Frankfort, Ind., to cost approximately $300,000.

The Union Pacific has awarded a contract to the Graver Corporation, East Chicago, Ind., for the erection of two 10,000 gal. per hour water softening plants at Fossil, Wyo., and Arden, Nev.

The Kansas City Southern will soon commence the construction of a one-story car repair shop 100 x 300 ft. at its terminal at Shreveport, La.

The New York, Chicago & St. Louis has acquired 200 acres at Fort Wayne, Ind., to be used for a new classification yard and freight terminal. An engine house and locomotive repair shop will also be constructed on the new site.

The Erie is arranging to close its locomotive repair shops at Dunmore, Pa., and proposes to abandon operations entirely at that point. Work will be concentrated at Hornell, N. Y., where construction is in progress on a number of shop buildings for heavy repair service.

The Philadelphia & Reading Railway will start work shortly on a large shop at Huntington, Pa.

The Chicago, Rock Island & Pacific has awarded a contract to Joseph E. Nelson & Sons, Chicago, Ill., for the erection of a 13-stall engine house at Shawnee, Okla.

The Galveston, Harrisburg & San Antonio will construct an addition to its roundhouse at San Antonio, Tex., to cost approximately $60,000.

The Illinois Central has awarded a contract to the Howlett Construction Company for the construction of a 300-ton reinforced concrete coaling station at Gilman, Ill.

The Atlantic City Coast Line will award contracts for the construction at Montgomery, Ala. The proposed shops will represent an investment of approximately $500,000, when completed.

The company had previously announced that it was planning to invest approximately $25,000,000 in improvements, to include purchase of new rolling stock, and construction and improvement of shops.

The Michigan Central has awarded a contract to the Ellington Miller Co. of Chicago, for the construction of a new engine house and shop at Grand Rapids, Mich.

The Baltimore, Chesapeake & Atlantic Railway has prepared plans for the construction of a one-story machine shop at Baltimore, Md.

The Atchison, Topeka & Santa Fe has purchased a 200-acre tract near Cassoway, Kan., as a site for an 800,000,000 gal. water storage reservoir.

The Union Pacific has awarded a contract to the Graver Corp. of East Chicago, Ind., for the erection of two 10,000 gal. per hour type "K" water softeners at Fossil, Wyoming, and Arden, Nevada.

The Atlantic Coast Line will construct a one and two-story, 100 x 320 ft. and 50 x 150 ft. coach shop, and a one and two-story, 100 x 320 ft. and 50 x 200 ft. paint shop at South Rocky Mount, N. C.

Items of Personal Interest

Theodore Tottenhof has been appointed assistant general boiler inspector, Union Pacific Railroad, with headquarters at Omaha.

D. R. McGrath has been appointed air brake instructor of the Chicago, Burlington & Quincy R. R. with headquarters at Chicago, Ill., succeeding **P. J. Murrin**, retired after fifty years service with the road.

Henry Harley Urbach, assistant master mechanic of the Galesburg division of the Chicago, Burlington & Quincy R. R. with headquarters at Galesburg, Ill., has been promoted to master mechanic of the Brookfield division with headquarters at Brookfield, Mo., succeeding **D. R. McGrath**, who has been assigned to other duties.

H. C. Gugler has been appointed master mechanic of the Wymore division of the Chicago, Burlington & Quincy R. R. with headquarters at Wymore, Nebr., succeeding **G. O. Huckett**, resigned.

H. C. Caswell has been appointed master mechanic of the Delaware, Lackawanna & Western R. R., at Binghamton, New York.

W. R. Keithley and **Monroe Brittian** have been appointed road foremen of equipment of the Arkansas-Louisiana division of the Chicago, Rock Island & Pacific Ry., with headquarters at Little Rock, Ark.

C. E. Francis, foreman of the erecting shop of the Pennsylvania at Trenton, New Jersey, has been appointed engine house foreman at Meadows, N. J.

B. Koontz has been appointed assistant road foreman of engines of the Seaboard Air Line with headquarters at Hamlet, N. C.

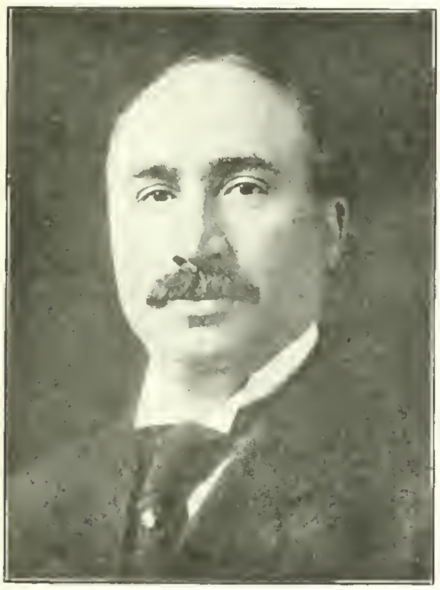
Don Nott, roundhouse foreman of the Chicago, Burlington & Quincy R. R., with headquarters at Galesburg, Ill., has been promoted to assistant master mechanic with the same headquarters, succeeding **H. H. Urbach**, promoted.

John Love has been appointed assistant master mechanic of the Lehigh & Susquehanna division of the Central Railroad of New Jersey, with headquarters at Mauch Chunk, Pa.

P. J. Colligan, master mechanic of the Chicago Terminal division of the Chicago, Rock Island & Pacific Ry., with headquarters at Chicago, has been promoted to superintendent of motive power of the Second district, with headquarters at El Reno, Okla., succeeding **W. J. O'Neill. C. B. Dailey**, master mechanic of the Cedar Rapids, Minnesota division, with headquarters at Cedar Rapids, Iowa, has been transferred to Chicago, succeeding Mr. Colligan. **T. W. McCarthy**, master mechanic of the Kansas division with headquarters at Horton, Kansas, has been transferred to Cedar Rapids, Iowa, succeeding Mr. Dailey.

Obituary

Charles Harris, for many years prominently identified with the iron and steel industry and railroad supply business, died at the French Hospital, New York City, October 21, at the age of 59. Death was due to a complication of diseases, his illness extending over a period of several weeks. Mr. Harris was held in high esteem by all who knew him. His high ideals of honor and his strict business integrity were proverbial among his friends and associates. His jovial nature and manner of greeting his friends will always be remembered by those with whom he came in contact. Mr. Harris was an excellent example of the finest type of man who quietly does his work with few public appearances, and nevertheless leaves a memory that will be cherished by the very large number whom he helped along.



CHARLES HARRIS

Joseph Hyde Ames, chief engineer of the American Car & Foundry Company, died suddenly at Chicago, on Oct. 11.

A. W. Gibson, master car builder of the Chicago, Burlington & Quincy R. R., died at his home, Aurora, Ill., Sept. 29.

Ralph Peters, president of the Long Island R. R., died suddenly at his home, Garden City, N. Y., Oct. 9. He was in his seventieth year.

Charles P. Steinmetz, chief consulting engineer for the General Electric Company, died October 26 from acute dilation of the heart at his home in Schenectady, N. Y. He was born at Breslau, Germany, on April 9, 1865. He was educated at the universities of Breslau and Berlin and in the Polytechnic at Zurich, Switzerland, specializing in mathematics, chemistry and electrical engineering. In 1889 he arrived in New York penniless and was only permitted to land through the efforts of an American traveling companion. His first position was in the drafting room of Osterheld & Eickemeyer at Yonkers, N. Y., where he received $2.00 a day. In a remarkably short time, Dr. Steinmetz made a name for himself by his original work on electric motors and generators and by his articles in the scientific papers. He was the author of many books on electric engineering.

Colonel Henry Stevens Haines, aged 86, a retired railroad civil engineer and at one time Vice President of the Plant System of railroads in the South, died November 3. He was born in Nantucket, was educated in Savannah, Ga., and with two brothers served for four years in the Confederate Army in the Civil War, being in charge of transportation engineers.

After the war Colonel Haines was identified with the Plant System for many years. He advised the Government of India how to change the gauge of its railroads and was chief consulting engineer for the city of Paris on the increase of its water supply. He wrote several books on American railroad management, which are standard works and have been translated into several languages, including Japanese. Colonel Haines formerly was President of the American Societies of Civil and Mechanical Engineers and the American Railway Guild.

Supply Trade Notes

John Baker has been appointed assistant vice-president of the **Locomotive Firebox Company**, Chicago, Ill., manufacturers of the Nicholson Thermic Syphon.

The Westinghouse Air Brake Co. announces the following appointments: **C. H. Larimer**, mechanical expert of the Westinghouse Air Brake Co. in the New England territory, has been appointed consulting mechanical expert. He is succeeded as mechanial expert by **R. P. Ives**, locomotive engineer from the New York, New Haven & Hartford Railroad. **H. J. Robinson**, for many years mechanical expert of the Westinghouse Air Brake Co., at Seattle, Wash., has been appointed superintendent of special training to supervise the special apprenticeship courses for college graduates at the company's Wilmerding plant.

The Westinghouse Air Brake Co. announces the opening of a new branch office at Houston, Tex., in charge of mechanical expert John Hume, assisted by C. A. Breit, who has been transferred from the company's office at St. Louis.

Joseph Wainwright has been appointed sales manager and **W. C. Chapman**, district manager of the Philadelphia, Pa., district for **Manning, Maxwell & Moore, Inc.**, New York. Messrs. Wainwright and Chapman will have headquarters in the Pennsylvania building, Fifteenth and Chestnut Streets. **Walter V. Lawton** has been appointed district manager of the Boston, Mass., district, with headquarters in the Textile Building, 99 Chauncy Street.

L. H. Rupert has joined the **Franklin Railway Supply Company**, New York, as Service Engineer. Mr. Rupert entered the service of the Santa Fe Pacific (now the Coast Lines of the A. T. & S. F. System) in 1897 as machinist's helper and extra fireman at Albuquerque, N. M. He left this road in 1899 to become a fireman on the Mexican Central Railway (now the National Lines of Mexico). He was promoted to engineer in 1902. Remaining with this company until 1911, Mr. Rupert then resigned to become locomotive engineer on the Mexico North Western Railway. In 1915 he left this road because of revolutionary troubles in Mexico.

The Linde Air Products Co., New York, recently started continuous operations in its new plant at Tulsa, Oklahoma. Oxygen will be extracted from the air by the liquefaction process. The plant is also able to reclaim the nitrogen and separate the rare gases, argon and neon. **C. A. Kennedy** is operating superintendent. A Prest-O-Lite plant, for manufacture of welding and cutting gas, is also planned for the same locality.

The Linde Air Products Company has recently started continuous operations in their newest oxygen producing plant, situated at Gwinnett Street and Stiles Avenue, Savannah, Georgia. **S. P. Wilson, Jr.**, is operating superintendent. An additional warehouse has also been opened at Charlotte, North Carolina, to serve customers in the Piedmont.

Phillip M. Kane, Jr., chief locomotive inspector at the Erie Railroad Company, Buffalo, New York, has resigned and taken the position of assistant engineer at the plant of the **Ferguson-Allan Company, Incorporated**, Buffalo, New York.

General Guy E. Tripp, Chairman of the Board, and **Loyall A. Osborne**, President of the **Westinghouse International Company**, in response to urgent cables from important Japanese interests, left for Japan on October 4. They will visit Shanghai, Hongkong, Pekin and the Philippines.

International Combustion Engineering Corp., at its next meeting of directors, the following will be elected to the board. **Joel S. Coffin**, chairman of board of **Lima Locomotive Works; A. H. Lockett**, vice-president of **Theodore Schulze & Co.; F. F. Fitzpatrick**, president of **Railway Steel Spring Co.; S. G. Allen**, secretary of the **Superheater Co.**, and **J. B. Terbell**, president of **American Brake Shoe & Foundry Co. J. S. Coffin** will be chairman and **S. G. Allen** vice-chairman.

The Westinghouse Electric & Manufacturing Company at their South Philadelphia Works has established a General Engineering Division which will be devoted to the study of central station and industrial plant problems, which involve the application of steam power apparatus, such as steam turlines, condensers and reduction gears. This department will also cooperate with the Sales Organization in providing engineering service to purchasers of this equipment.

P. E. Stickler is now connected with the **Franklin Railway Supply Company,** New York, as service engineer. Mr. Stickler entered upon railroad work as an engine watchman and extra fireman on the K. C. Division of the Chicago, Milwaukee & St. Paul in 1901. In 1906 he accepted a position as a fireman on the Iowa lines of the C. B. & Q. In 1911 he went to the Tucson, Arizona, division of the Southern Pacific as a fireman, being promoted to engineer in 1917, and remaining with this road until his resignation to join the Franklin Railway Supply Company.

D. S. Murphy, who is well known in railroad circles, is now chief service engineer of the **Franklin Railway Supply Company, Inc.,** New York. Mr. Murphy was born at Visalia, California, and attended schools in that state and in Missouri. He began his railroad career in 1903 with the Missouri Pacific Railway in yard and station service. He was connected with the transportation department of that road until 1906, when he joined the operating department of the Missouri, Kansas and Texas Railway at St. Louis. From 1913 to 1917, Mr. Murphy was office assistant to president of the M. K. and T. From 1917 to 1918 Mr. Murphy served in a similar capacity with the Federal Manager (United States Railroad Administration) of the group comprising the St. Louis & San Francisco Railroad, Missouri, Kansas & Texas Railway and several smaller lines. On March 1, 1918, he was appointed trainmaster of the St. Louis division, Missouri, Kansas & Texas Railway, and in May of the same year trainmaster of the Osage division. On September 15, 1918, he was again promoted, this time to superintendent of the Oklahoma district, with headquarters at Oklahoma City, Oklahoma. On March 1, 1920, he was made superintendent of the McAlester district, with an office at Muskogee, Oklahoma, a position which he resigned this year to become chief service engineer of the Franklin Railway Supply Company, Inc.

Charles M. Brown, sales manager of the **Colonial Steel Company,** Keystone building, Pittsburgh, Pa., has been elected president, and **J. Trautman,** assistant sales manager has been appointed sales manager to succeed Mr. Brown.

New Publications

THE WELDING ENCYCLOPEDIA, Third Edition. Compiled and edited by L. B. Mackenzie and H. S. Card of the Editorial Staff of The Welding Engineer.—437 pages; 600 illustrations; bound in flexible leather grain binding; gilt edges. Published by The Welding Engineer, 608 S. Dearborn St., Chicago, Ill.

A reference and instruction book on the theory and practice of all the welding processes. Words, terms and trade names used in welding practice and found in welding literature are arranged alphabetically, and carefully defined. Especially important words and terms are made the subject of complete illustrated treatises. The definitions and discussions comprise what is called the Encyclopedia Section. Then one chapter is devoted to oxyacetylene welding, electric arc welding, thermit welding and resistance welding. Additional chapters treat separately of boiler welding, pipe welding, tank welding, rail welding, taking into account the use of both gas and electric processes. A section devoted to rules and regulations tells how to install and care for welding apparatus, and describes the limitations imposed on the applications of the processes by federal, state and insurance regulations. A special chapter deals with the subject of the heat treatment of steel, and this is followed by a collection of charts and tables of useful welding information.

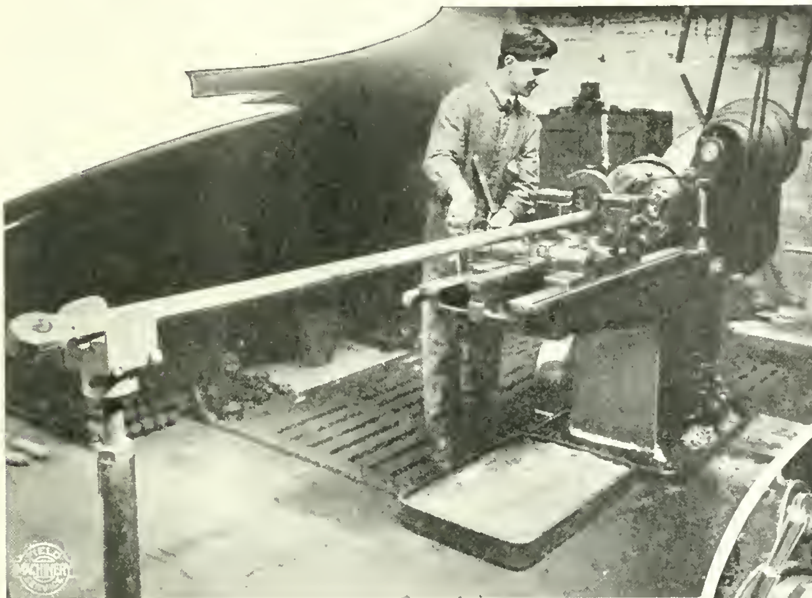
Another feature of the volume worthy of special mention is the section devoted to percussion welding, pages 197-199. Many will be interested to know that it is not only possible but practical to weld together in the small fraction of a second two metals of different fusing points and characteristics, the operation being completed so quickly as to preclude oxidation or excessive heating. A full explanation and description of the mechanism used in percussion welding will be found in the book under consideration.

There is a Catalog Section at the end of the volume which illustrates and describes the leading makes of welding apparatus and supplies. A new feature has been added in publishing the Third Edition which gives an entirely new character to the book. This is the chapter on "Training Operators." A complete outline of lessons furnishes the instructor with a logical plan of instruction, and gives a reading reference directing him to the portions of THE WELDING ENCYCLOPEDIA which cover these topics. This is followed by a set of exercises and a set of examinations. Both oxyacetylene welding and electric arc welding instructions are handled in this manner in the instruction outlines, giving the welding instructor and the welding student an opportunity to get full value from all of the information contained in the text.

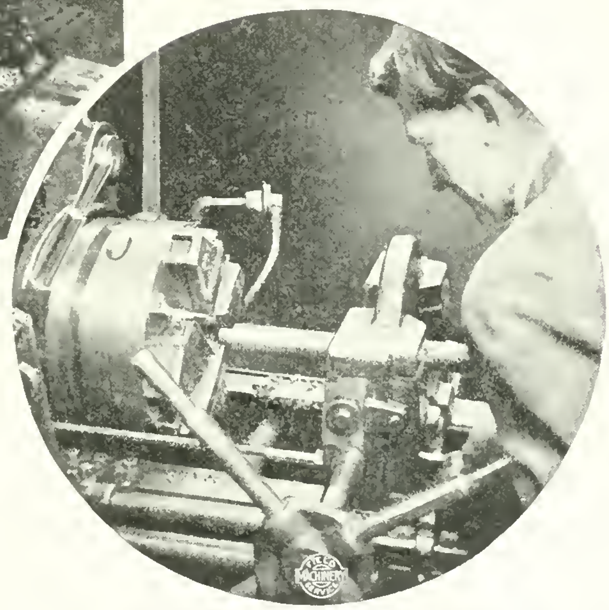
Each succeeding issue of the Welding Encyclopedia brings the work right up-to-date with much additional new material. The compilers and editors are "taking the guess work out of welding" so effectively, that the element of guess will soon be a negligible quantity in the art.

New Torchweld Catalogue. The Torchweld Equipment Company, 224 N. Carpenter Street, Chicago, have issued a new catalogue covering its complete line of oxy-acetylene welding and cutting apparatus, lead welding, soldering, brazing and decarbonizing units, automatic machines, gas pressure regulators, generators and supplies. The catalogue contains cross sectional views of equipment with detailed explanation. The catalogue is 8½" x 11", and consists of 40 pages. A copy may be obtained on request.

Around the World with Landis



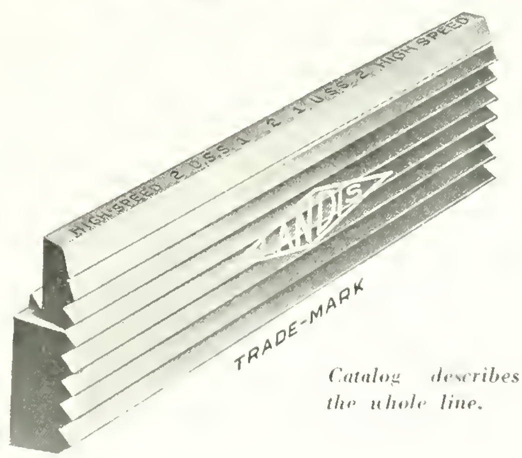
At the Wolverton Shops of the London & N. W. Railway—The Backbone of Britain's Transportation Service.



Three Landis Threading Machines (one single and two double) have seen practically continuous service, for several years, in this famous British R. R. Shop, where they are rated the most popular machines in their class. Of the two shown, one is threading draw bars of steel—32—37 tons tensile strength—the thread being 7" long, 2" diameter, $4\frac{1}{2}$ per inch Whitworth pitch. The other is threading coupling pins made of the same grade of steel; with a $1\frac{3}{4}$" diameter thread, a distance of 7" at each end.

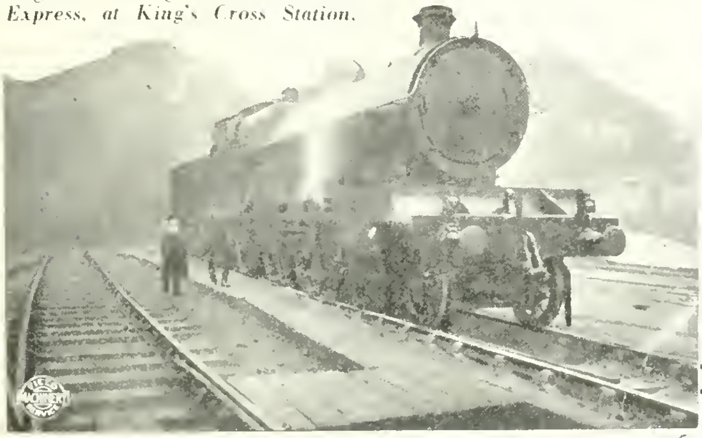
Both machines are operated by apprentices, and the works engineer says he "prefers the Landis Die Head because the chasers last a long time and give good, clean threads," every one of which (incidentally) must pass a rigid inspection.

Landis Bolt and Pipe Threading Machines are giving satisfactory, reliable service all over the world—increasing output and reducing threading costs in practically every industry.



Catalog describes the whole line.

One of the latest "Great Northern" Engines backing into the Scotch Express, at King's Cross Station.



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Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

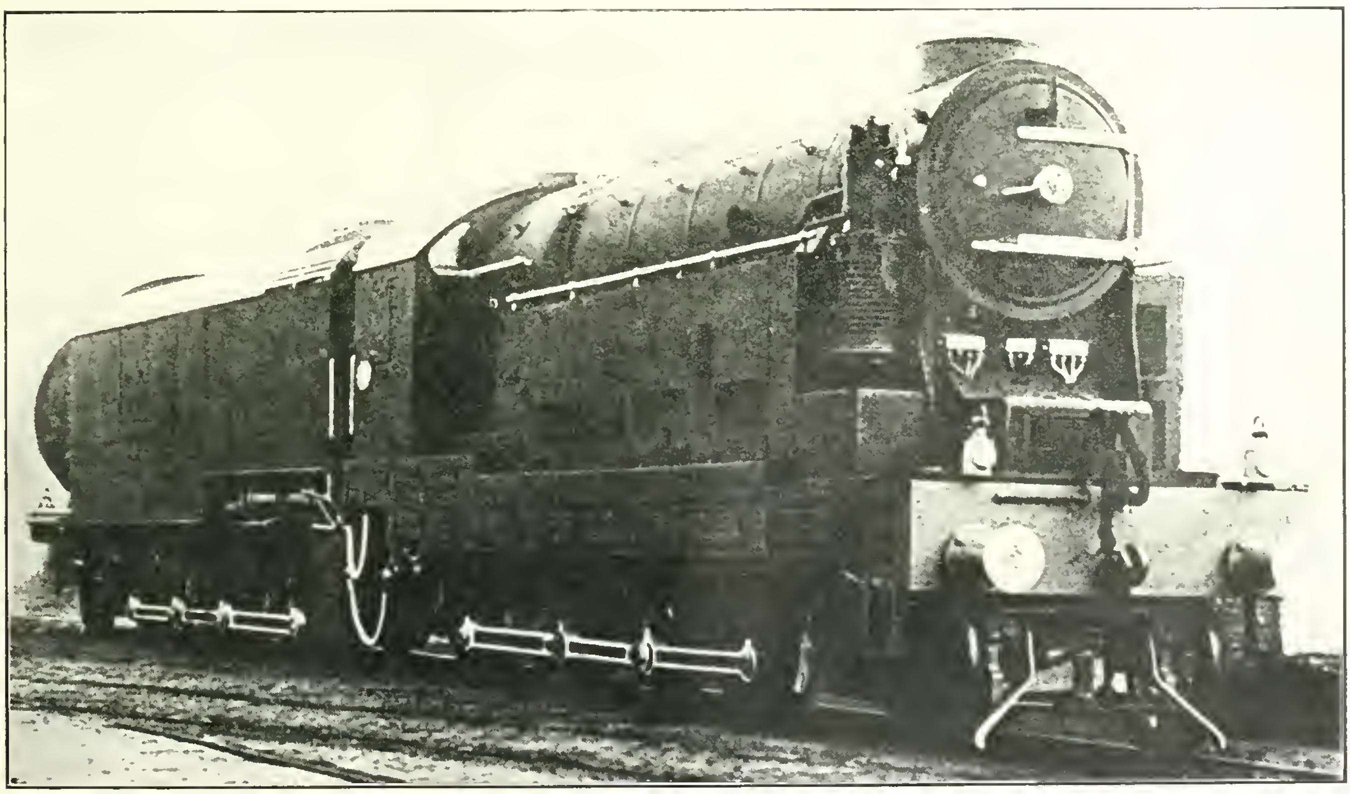
Vol. XXXVI — 114 Liberty Street, New York, December, 1923 — No. 12

The Ramsay Condensing Turbine Electric Locomotive

A New Adaptation of the Turbine to Locomotive

A new type of turbine locomotive has been built by the Ramsay Condensing Locomotive Co. of Glasgow, Scotland. Like its predecessor, the Reid-Ramsay turbine electric locomotive, built in 1910, it uses a steam turbine for driving an electric generator by which current is supplied to the driving motors.

The engine is made in two sections, which are held together at the center by a universal joint. The boiler is located on the front section and beneath it are the main and auxiliary turbines and generators. The rear section contains the condenser with its fan, the water tanks and coal space.



The Ramsay Condensing Turbine Electric Locomotive

The boiler develops a steam pressure of 200 lbs. per sq. in., which is superheated 300 degrees Fahr. before reaching the turbine. The boiler has a heating surface of 1,243 sq. ft.; 300 sq. ft. of superheater surface, and a grate area of 38.5 sq. ft. It has a forced draft developed by a fan placed in the cab.

The main turbine is of the impulse type and contains nine stages, the mean blade diameter being 36 in., and runs at a speed of 3,600 revolutions per minute. By the use of a condenser the steam is exhausted down to a vacuum of 27½ in.

The connection to the condenser is made by means of an exhaust pipe which is provided with a flexible rubber coupling, reinforced with aluminum rings.

The condenser consists of an annular nest of tubes built into two headers, the exhaust steam from the turbines enters one header, passes through the tubes, is condensed and the water resulting from the condensation is collected in the other header. From there the water passes into a well and is eventually returned to the boiler to be converted into steam again. The accelerated evaporative principle is employed in the condenser.

The nest of tubes is in the form of a drum which rotates in bearings. The drum is housed in a tank the bottom of which contains water kept by a pneumatic float valve at a constant level. The tubes pass through the water as they rotate. After they leave the water rapid evaporation is produced by passing air at a high velocity over them and the result is equally rapid condensation of the steam inside the tubes. The air is supplied by a specially designed fan.

The inlet to the fan is provided with a scoop or air guide which forms an easy path for the entering air and so eliminates the losses from the shock which would occur if no such provision were made.

The water used in the boiler and that used for wetting the tubes are kept separate. The former is used in a closed circuit and is not wasted except for small leakages, hence very little make-up is required. The advantage of

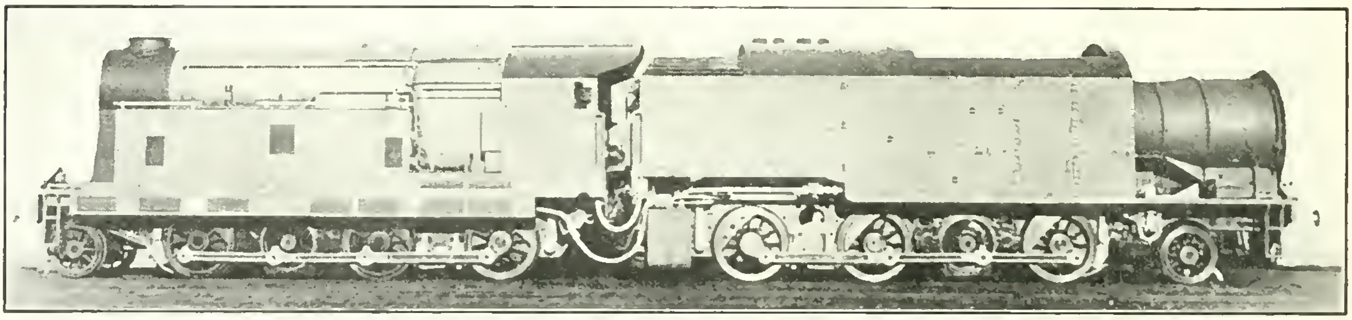
Each two motors is bolted to a center stretcher carrying a transmitting shaft and spur wheels. Pinions are keyed to the motor shafts and gear with the spur wheels and the power is transmitted through coupling rods from the spur wheels to the driving wheels in the ordinary manner.

The following are the tractive efforts at the rim of the wheels for the acceleration period from starting to 60 miles per hour.

M.P.H.	Tractive effort
Starting	22,000 lbs.
15	22,000 "
30	11,050 "
60	8,600 "
Normal running 60 m.p.h.	6,000 "

The starting torque of the motors is about three times that of the normal and it is obtained as follows:

Before starting the locomotive the auxiliary turbine is



Side View, Ramsay Condensing Turbine Electric Locomotive, Built by Sir W. G. Armstrong, Whitworth & Co., England

this is specially felt where locomotives have to pick up bad water during runs resulting in rapid deterioration of the boiler. By using a condensing system, taking in bad water during runs is obviated as ample water can be carried to satisfy any run that the locomotive may be called upon to perform. A prolonged life of the boiler is insured in any case by using a condensing system because shortly after the run the water bec mes partially distilled.

Regarding the wetting of the tubes impure water does not affect the vacuum, neither does it injure the tubes as repeated tests have shown this to be the case, hence any water may be used for condensing purposes. The main turbine is coupled direct to the generator, whose energy is transmitted to four motors, two of which are fitted to the wheels of the front section of the engine and two to those of the rear.

The generator is of the three-phase type and is designed to develop 890 kilowatts at 3,600 revolutions per minute, at a voltage of 600.

The auxiliary turbine, which is a single stage one, drives a direct current dynamo which excites the poles of the main generator and also provides electrical energy for the motors driving the condenser fan, the condenser rotor and the extraction pump and also the current for lighting the train.

This turbo-set runs at 3,600 revolutions per minute and is subjected to the same steam conditions as the main turbo set.

The four main driving motors are of the alternating current slip ring type, ventilated by fan runners mounted on the rotor shafts. The continuous output capacity of each is 275 brake horsepower with one hour's rating at 360 brake horsepower. The speed of the motors at 60 miles per hour is 1,175 revolutions per minute, and at 600 volts.

run up to full speed thus providing excitation for the main generator and energy for the auxiliaries. The main turbine is then run up to half speed, viz., 1,800 revolutions per minute. At this point the motors are connected in series, and the locomotive may then be started.

When the speed of the turbine increases from rest to full speed, its torque decreases in the ratio of two to one and at half speed its torque is one and one-half times the normal and this is the torque of the main turbine when running at 1,800 revolutions per minute.

It is well known that two alternating motors when connected in series and running at half the speed of the generator have, as is known, twice the turning moment which they have when connected in parallel with the same power consumption. Therefore, with the motors in series and the turbine running at half speed, the torque from rest to quarter speed will be two times one and a half or three times the normal torque.

When this point has been reached the motors are connected in parallel while the turbine is still running at half speed, when the speed of the locomotive will increase from one-quarter to one-half speed, and the motor torque, at this last speed, will be one and one-half times the normal. The speed of the turbine is then brought up to its maximum, when the torque drops from one and a half times the normal to the normal.

When the main and auxiliary turbines have been brought to speed by means of a handwheel in the cab which regulates the steam inlet, all control of the locomotive is then effected electrically by means of the control wheel on the controller fixed in the cab, the main turbo-generator running at 1,800 revolutions per minute.

Then with the control wheel in the zero position the motors are without current and connected in series.

In order to start the locomotive the control wheel is moved to the first notch, thereby closing the excitation circuit to the turbo-generator and connecting the motors in series, and with all the resistances in the circuit.

Any further movement of the control wheel will cut out the resistance until the first running position of 15 miles per hour is reached. If it is desired to run at a higher speed, the control wheel is moved further so as to change the motor connections from series to parallel, when the excitation circuit will be again closed, the motors once more operating under current and the resistance will be again cut out until the second running speed of about 30 miles per hour is reached.

There are more notches provided on the controller, each of which corresponds with a given speed of the locomotive.

These speeds are reached by further moving the control wheel round, step by step, whereby the setting of the main turbine governor is correspondingly altered, i. e., the speed of the turbo generator is increased and thereby the periodicity. In this manner the locomotive speed can be increased from 30 to 60 miles per hour.

When the speed of the locomotive is to be reduced, the controller wheel is first turned quickly back to the zero position, thus passing in reverse succession through the notches as was done for starting up to full speed. When the excitation circuit is thus opened, the notches are without current and are connected in series ready for starting again.

By disconnecting the terminals of the generator from the motor and connecting them to water resistances the turbine and generators can be run when the locomotive is at rest, the electrical energy being dissipated by heating up the water. This affords a very convenient means of testing the condenser and taking readings which would be very difficult to get while in motion. Numerous tests have been made under these conditions and very valuable data collected.

The trials of this locomotive have been very exhaustive and have extended over a period of more than eighteen months.

In addition to these many runs have been made between Horwich & Bolton and two between Horwich and Southport.

During all these runs a breakdown has never occurred and in no single instance has it been necessary to use the ordinary steam pilot engine which accompanies the Ramsay turbine-electric locomotive on its run, thus proving that the system is reliable.

On one of the runs to and from Southport, a distance of 100 miles was traversed and a speed of 60 miles per hour attained with a load of 275 tons.

The tests have demonstrated among many other things the important point upon which the efficiency of the turbo-condensing locomotive mainly depends and that is that a condenser has now been made which can be placed within the confined space of the locomotive and which will maintain the required vacuum necessary to deal economically with very large loads.

It is to be understood that this present locomotive is a purely experimental one and is to be used for that and demonstration purposes only, with no expectation of its being used permanently in regular service.

Three-Cylinder Freight Locomotive on the New York Central

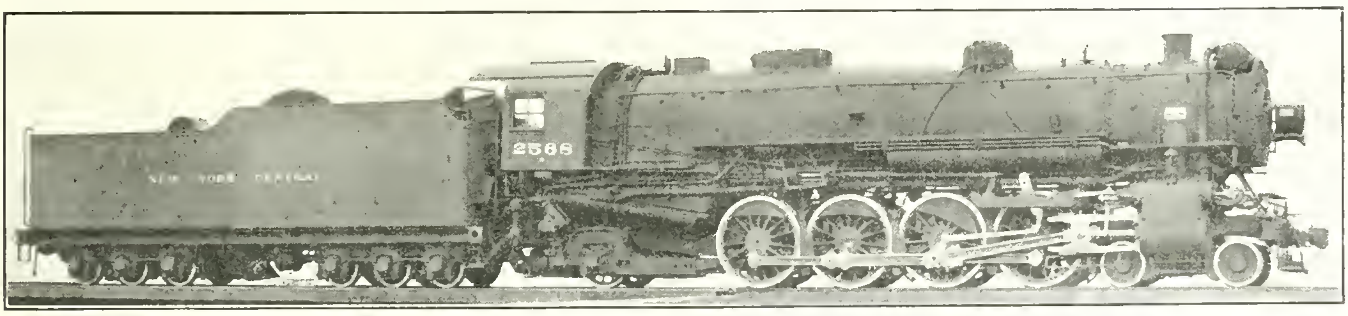
The First Application of the Three-Cylinder Principle to a Heavy Freight Engine

Sometime ago the American Locomotive Company constructed for experimental purposes a three-cylinder simple locomotive and which has been in freight service on the Mohawk Division of the New York Central for the past several months.

The engine is of the 4-8-2 wheel arrangement which is known as the Mohawk type on the New York Central, and in design is similar to the two-cylinder simple locomotives that have been in service on this road, and which were described in the September, 1917, issue of Railway and Locomotive Engineering.

The locomotive was constructed to determine whether the division of work between three sets of pistons, crossheads and main rods would be desirable in a heavy freight locomotive, as well as to determine whether the three cylinders will make possible an increase in thermal efficiency by more expansive use of the steam, and dynamometer tests are to be conducted to ascertain its performance as to hauling and fuel consumption which will afford opportunity for comparison with the two cylinder locomotive of the same general design.

The three simple cylinders are 25 in. in diameter and 28-inch stroke. The type E superheater and the Elesco feed water heater is used as is also the trailer truck booster of the Franklin Railway Supply Company. With the aid of the booster, the locomotive exerts a maximum tractive force of 75,700 lbs., as compared with 51,400 lbs., for the two cylinder Mohawk type.



Three-Cylinder Mikado Type Locomotive of the New York Central—Built by American Locomotive Company

From a mechanical standpoint, the most important benefit of the three-cylinder arrangement is the reduction of stresses on each set of pistons, crossheads and main rods. In this case, while the three cylinder arrangement increased the tractive force 21 per cent, it also reduced the piston thrust, based on 200 lb. pressure from 123,000 lb. to 98,000 lb., or 20 per cent. The even turning moment on the driving wheels obtained with three cylinders is also advantageous in permitting the use of a lower factor of adhesion. In any locomotive, the adhesive weight must be great enough to prevent slipping with the maximum tractive force developed throughout a complete revolution. In a three-cylinder locomotive, the maximum is only 8 per cent higher than the average, while with the two cylinders, it is 23 per cent above. This means that for a given weight on drivers the three-cylinder locomotive can develop 15 per cent greater rated tractive force than a two-cylinder design without increasing the tendency to slip the wheels. The factor of adhesion used on the three-cylinder locomotive is 3.73 which would be equivalent to about 4.29 in the two-cylinder type.

The two outside cylinders of the locomotive are placed horizontally with the center lines 2 in. above the centers of the wheels. The center cylinder has been inclined at an angle of 8½ deg. This brings the front end of the cylinder higher than the bottom line of the boiler barrel and the bottom side of the smokebox has been raised at the forward end to give the required clearance. The right and center cylinders and valve chambers are made in a single casting which extends to the inner side of the left frame where it is bolted to the left cylinder casting.

The crank axle is of the built-up type with step fits in the crank cheeks. The inside crank pin has a bearing 7½ in. wide by 12 in. in diameter. This bearing is lubricated with hard grease which is forced in from the outside of the axle and passes through holes in the crank cheeks and the center crank pin to the surface of the bearing. The center guides, which are of the two-bar type, are lubricated through oil pipes from the running board.

A feature of the design is the method of driving the valve for the inside cylinder from the outside valve gear. The center lines of the three valves are all horizontal and at the same height. A transverse forked lever is placed ahead of the cylinder castings, one end of the lever being connected to the front extension of the left valve stem, the stationary fulcrum being one-third the distance from the opposite end. The right-hand end of this lever forms a fulcrum for the center of a floating lever, one end of which is connected to the right valve stem, while the other end drives the valve for the center cylinder. This simple arrangement avoids the necessity for the third set of valve motion. In order to facilitate the application of valve motion levers, the bumper beam braces are secured by pins at the top and bottom ends, making them readily removable. Double ported piston valves, 11 in. in diameter, are used for all three cylinders. The valves have a maximum travel of 6 in. with 1⅛-in. lap, ⅛-in. exhaust clearance, and 3/16-in. lead.

To permit the application of the booster a cast-wheel Delta type trailer truck with equalizers between the driving wheels and trailer truck was installed. The Delta truck is manufactured by the Commonwealth Steel Company, St. Louis, Mo.

The tender is of the rectangular bottom type and has a cast-steel frame carried on the six-wheel truck of the Commonwealth Steel Company.

The following table gives the general characteristics and dimensions of the locomotive:

Table of Dimensions, Weights and Proportions

Type of locomotive	4-8-2
Service	Freight.
Track gage	4 ft. 8½ in.
Cylinder diameter and stroke	3—25 in. by 28 in.
Valve gear, type	Walschaert.
Valves, type, size	Double ported. Piston—11 in.
Maximum travel	6 in.
Outside lap	1⅛ in.
Exhaust clearance	⅛ in.
Lead in full gear	3/16 in.
Weights in working order:	
On drivers	241,500 lb.
On front truck	66,000 lb.
On trailing truck	59,500 lb.
Total engine	367,000 lb.
Tender	267,800 lb.
Wheel bases:	
Driving	18 ft. 0 in.
Rigid	18 ft. 0 in.
Total engine	40 ft. 9 in.
Total engine and tender	82 ft. 6 in.
Wheels, diameter outside tires:	
Driving	69 in.
Front truck	33 in.
Trailing truck	45 in.
Journals, diameter and length:	
Driving, main	11½ in. by 13 in.
Driving, others	11 in. by 13 in.
Front truck	6½ in. by 12 in.
Trailing truck	9 in. by 14 in.
Boiler:	
Type	Conical
Steam pressure	200 lb.
Diameter, first ring, inside	80 in.
Firebox, length and width	114¼ in. by 84½ in.
Arch tubes, number and diameter	4—3 in.
Combustion chamber length	None.
Tubes, number and diameter	None.
Flues, number and diameter	216—3½ in.
Length over tube sheets	24 ft. 11 in.
Gas area through tubes	328 sq. in.
Net gas area through flues	1,054 sq. in.
Total gas area through tubes and flues	1,382 sq. in.
Grate area	66.9 sq. ft.
Heating surfaces:	
Firebox and comb. chamber including arch tubes	242 sq. ft.
Tubes and flues	4,913 sq. ft.
Total evaporative	5,155 sq. ft.
Superheating	2,158 sq. ft.
Comb. evaporative and superheating	7,313 sq. ft.
Special equipment:	
Brick arch	Security.
Superheater	Type E.
Feedwater heater	Superheater Co.
Stoker	Elvin.
Booster	Franklin.
Tender:	
Style	Rectangular.
Water capacity	15,000 gal.
Fuel capacity	16 tons.
Trucks	6 wheel.
General data estimated:	
Rated tractive force, 85 per cent	64,700 lb.
Tractive force of booster	11,000 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	65.8
Weight on drivers ÷ tract. force	3.73
Total weight engine ÷ comb. heat. surface	50.2
Boiler proportions:	
Tractive force ÷ comb. heat. surf.	8.85
Tractive force × dia. drivers ÷ comb. heat. surf.	611
Firebox heat. surface ÷ grate area	3.62
Firebox heat. surface, per cent of evap. heat. surface	4.70
Superheat. surface, per cent of evap. heat. surface	41.9

The Half-Stroke Cut-Off Locomotive

Four Years of Successful Operation on the Pennsylvania

In the February, 1920 issue of RAILWAY AND LOCOMOTIVE ENGINEERING there was published a description of the then new half-stroke cut-off locomotive that had been designed for use on the Pennsylvania R. R. This description with the illustrations was derived for the most part, from Bulletin No. 31 issued by the railroad company.

At the November, 1923 meeting of the New York Railroad Club, Mr. W. F. Kiesel, Jr., the mechanical engineer of the Pennsylvania, read a paper on this half-stroke cut-off locomotive, in which he gave considerable data in addition to that contained in previous publications.

The tests made on the locomotive testing plant showed a saving in steam consumption of about 23 per cent when developing 2,900 horse power, as compared with a Mikado locomotive of about the same capacity. This figure has been nearly equalled in operation on the road where it has been found, that the average saving of steam in heavy freight service is at least 20 per cent.

In the previous article attention was called to the high steam pressure of 250 lbs. per sq. in. that is used. This is necessary because the friction pressure has to be at least twenty-five per cent, greater than for a locomotive with 90 per cent cut-off. This may be obtained either by increased cylinder dimensions or by increased pressure or by both. Such an increase of pressure involves an increase in the weight of the reciprocating parts and counterbalance. This increase of reciprocating weights, which is the only factor of a negative nature that need be considered, will be closely proportional to the increase of piston pressure.

The revolving weights for the main wheels will also be increased, since the back end of the main rods, and the main crank pins, must withstand the increased piston pressure.

The side rods, being designed to slip the drivers—which they actuate—require no modification, as the weight on drivers need be no greater.

These weight increases amount to about 1⅛ per cent of the total weight of a heavy Mikado locomotive.

To keep the same weight of locomotive, there will have to be a reduction of 1⅛ per cent if the pressure is not increased, or of 2¼ per cent when the pressure is increased, which will, necessarily, have to be taken from the size of the boiler.

A reduction of 10 per cent in heating surface, and the other features governed thereby, will fully meet this requirement.

From the locomotive experience with simple engines, we know that the lowest water rates obtain between 20 per cent, and 50 per cent cut-off. We also know that, for starting, a cut-off of at least 80 per cent should be available.

Train resistance, which the power of the locomotive must overcome is large for starting, but drops quickly with increase of speed up to about 2½ miles per hour, and then gradually increases with increasing speed.

The author then went on to show that, according to the ordinary methods of calculating tractive effort by the work done in the cylinders, that of two locomotives, each having cylinders of 27 in. diameter and 30 in. stroke, would be practically the same above 8 miles per hour if one had a maximum cut-off of 91 per cent, and a steam pressure of 200 lbs. per sq. in., while the other had a maximum cut-off of 50 per cent and carried a pressure of 250 lbs.

For speeds of less than 8 miles an hour the tractive effort of the 50 per cent cut-off locomotive increased rapidly as compared with the other until, at starting it becomes about 15 per cent greater than the other.

In full gear operation, when hauling heavy loads, the steam consumption of the 50 per cent cut-off locomotive is 30.6 per cent less than with the 91 per cent cut-off. For such operation, this would permit making the boiler 30 per cent less in value than that of the ordinary locomotive. Now, on the equal locomotive weight basis, it need be only 10 per cent less in order to show a coal saving greater in per cent than the water saving. Again the water saving indicates that the radius of operation on a given amount of water may be increased 44 per cent. That is, for the same train the 50 per cent cut-off locomotive working in full gear can go 44 per cent further before it must stop to take water.

In coal consumption, it appears that there is a saving of 43 per cent when the water saving is 30.6 per cent, so that there will be an increase in the distance run of 75 per cent before it will be necessary to take coal. This is, of course, the extreme of economy, which cannot be realized, as an average, in any service, except possibly in shifting work.

In the bulletin issued in regard to the locomotive four years ago, two diagrams were published of the tractive effort curves of the 50 and 90 per cent maximum cut-off locomotives. From these it appeared that "in the case of the decapod cutting off at half-stroke, the turning moment forms nearly as smooth a curve as for the Mikado cutting off at nearly full stroke."

Later analyses as given in the paper show that the torque for the 50 per cent cut-off locomotive is practically as uniform as that of a three-cylinder locomotive with a crank axle. Both of which are much smoother than the curve of a 90 per cent cut-off locomotive.

This is shown in Figs. 1 and 2, which show the tangential turning force exerted on the wheels of the Mikado locomotive, assumed with a ratio of length of main rod to crank of 8.6. Figure 1 represents that for the 90 per cent cut off locomotive, giving a maximum torque of 125.3 per cent; and Figure 2 that for the 50 per cent cut-off locomotive, giving a maximum torque of 113.6 per cent. For the latter, this would permit an increase in cylinder pressure of 10 per cent, without increasing the danger of slipping.

It will be realized that no hard and fast rules can be formulated, on account of variations in main rod and crank lengths, but, from studies thus far concluded, the indications are that the ratio of maximum to minimum tangential pressure is at least 20 per cent greater, at 90 per cent cut-off than at 50 per cent cut-off.

At speed, for earlier cut-off points, the uniformity of torque depends mainly on careful arrangements of valve events, based on weight of reciprocating parts.

Uniformity of torque decreases the possibility of slipping, and tends to decrease the wear and tear of the machinery, to some extent.

Consequently, the ratio of cylinder tractive effort to weight on drivers may be increased, or, with the same ratio, the slipping will thus be materially decreased.

Having considered the various features of the 50 per cent cut-off locomotive, in comparison with the current type locomotive we may expect an average saving of about 20 per cent. for slow speed and heavy service; a saving of 10 to 15 per cent in fast freight; and a saving of nearly 10 per cent for medium loads and high speeds.

The increased reciprocating weights must be given due consideration. For slow speed, the effect thereof is of little importance. For high speed, these increased weights are much more important.

For high speed passenger service, it may be assumed that the negative effect of the 25 per cent increase of reciprocating weights balances the positive effect of a possible 10 per cent saving in coal and water.

On the other hand, when considering slow speed freight service, the effect of increase in reciprocating weights

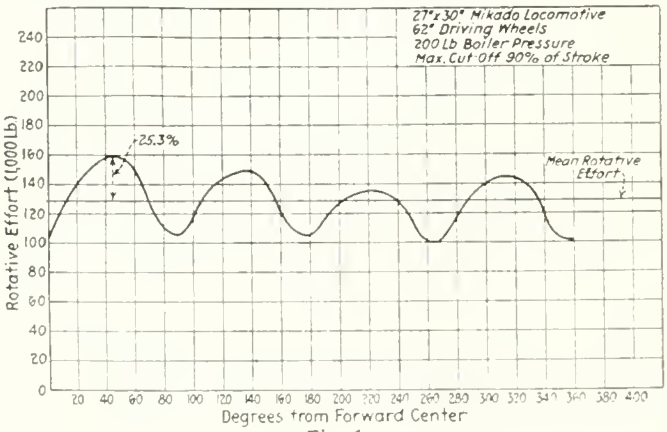


Fig. 1

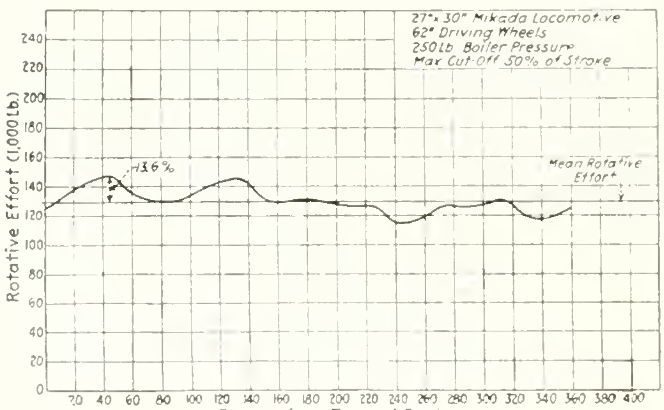


Fig. 2

is negligible, and the saving of 20 per cent of coal becomes paramount.

The results in service have fully substantiated the expectations based on the tests set forth in Bulletin No. 31. These showed that, under adverse circumstances the 50 per cent cut-off locomotive showed a material saving over the long cut-off locomotive.

That there is a saving of steam of 38.7 per cent at 40 revolutions per minute and 31.6 per cent and 60 revolutions per minute in full gear operation.

That a 50 per cent cut-off shifter should save at least one-third of the water which would be used by a long cut-off shifter.

That at higher speeds and other cut off points, the saving in water and coal is less.

That a saving of water of from 11.6 to 38.7 per cent is indicated.

That the actual coal saving is dependent on the value of the boiler used.

John E. Muhlfeld Again Designs Something New in Motive Power

When the Baltimore & Ohio brought out in 1904 the first Mallet compound locomotive and exhibited it at the St. Louis Exposition, there were many who were quite outspoken in their prophecy as to its short career, but the designer builded better than he knew, as is evidenced by the wonderful growth of this type of locomotive, and the important part it now plays in the economic status of American railways.

At the introduction of the first Mallet engine in America John E. Muhlfeld was at the time general superintendent of motive power of the Baltimore & Ohio Railroad. Mr. Muhlfeld now has under construction and will have placed in service early next year an improved design of locomotive which in general follows the characteristics outlined in the paper, Scientific Development of the Steam Locomotive, which he presented to the American Society of Mechanical Engineers in December, 1919. Not only the steam locomotive is treated in this paper, but reference is made to electrification of steam railways in comparison with steam operating results, bringing out many interesting points on this phase of the question. The author took the broad position that: despite the fact that marked progress has been made in the development of the steam locomotive, there still remains considerable opportunity for further improvement, and the general lines along which such improvements should be made form the supporting data for the paper, the substance of which is:

The work developed by a steam locomotive is measured in drawbar pull and drawbar horsepower and its hauling power at speed is dependent entirely upon its ability to maintain the mean effective pressure. In other words, a locomotive developing a pull of 12,000 lb. at the drawbar at a speed of 37½ miles per hour travels at the rate of 3,300 ft. per min. and develops 39,600,000 ft.-lb. or 1,200 drawbar hp. When developing 6,000 lb. drawbar at 75 miles per hour the rate will be 6,600 ft. per min. and the drawbar hp. developed will be 1,200, or the same as in the previous case. Therefore drawbar pull should be considered as the force required to do the work and drawbar horsepower should be considered as the measure of the rate for doing the work, and the two should not be confused in calculating the hauling capacity and speed which may be produced by any type of locomotive.

Modern types of locomotives have developed at low speeds 3,000 i. hp. and at high speeds 3,200 i. hp., and comparative average water rates through the complete range of the effective capacity of the locomotive, with piston speeds of from 600 to 1,000 ft. per min., have been obtained. At piston speeds of less than 600 ft. per min. the water rate of the double-expansion saturated-steam locomotive will approximate that of the single-expansion super-heated-steam locomotive.

With the exception of the Mallet articulated type of compounding, the multiple-expansion system of steam utilization, which has been so successful in marine and stationary practice, has not made the progress in this country that it has in Europe.

The failure of various types of cross, four-cylinder, four cylinder balanced and tandem double-expansion locomotives, introduced from 25 to 15 years ago, to produce the predicted economy was due largely to factors of indifferent design, low boiler pressure, excessive condensation, lack of proper maintenance and operation, poor fuel and road failures. Clearance limitations also restricted the size and arrangement of the low-pressure cylinders, while at the same time the single-expansion-cylinder super-heated-steam locomotive gave opportunity for greater hauling capacity and economy.

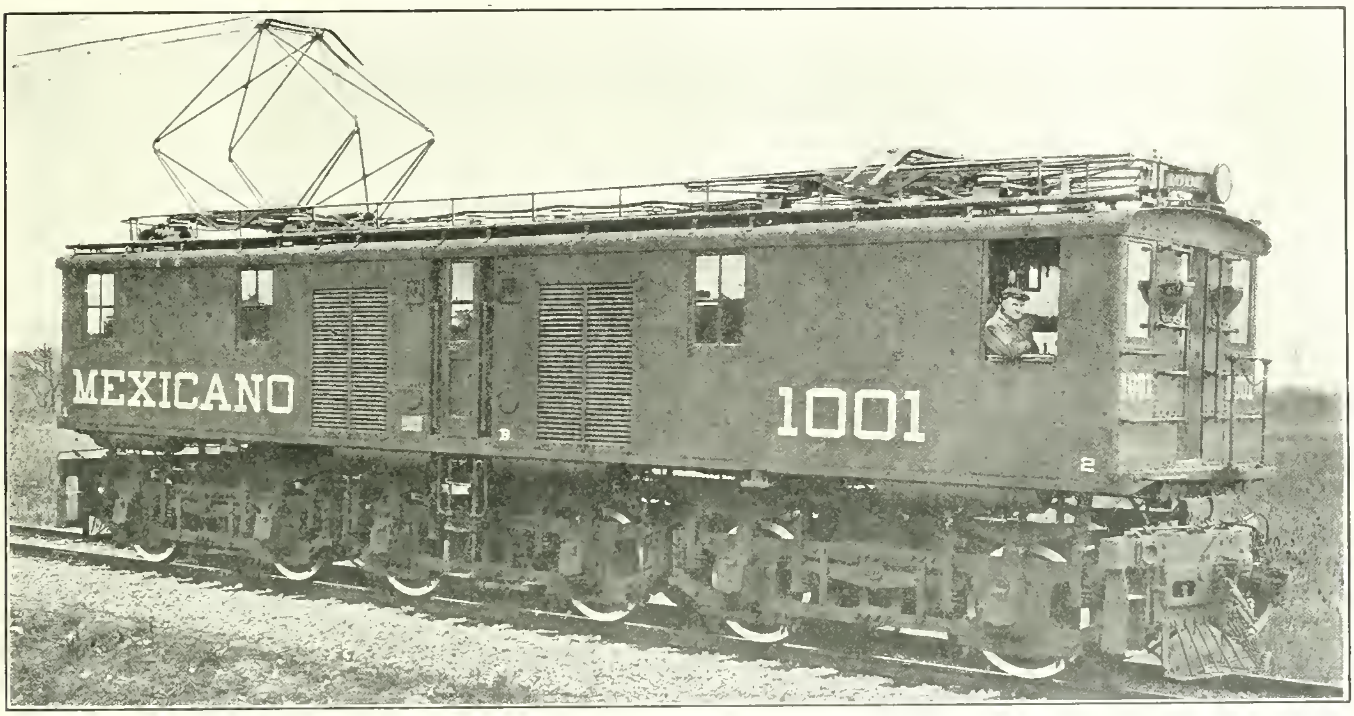
action on the rails of each separate wheel of a locomotive or motor car. The otheograph test tie, or several of them in combination, gives a graphic record of the amplitude and characteristic of both the vertical and transverse thrust of all the wheels on each rail. These tests were watched with special interest.

The Paris-Orleans locomotive was designed for the purpose of supplying a unit having approximately 80 tons on drivers and having maximum free running speed up to 130 kilometers (80.8 miles) per hour. The locomotive manufactured jointly by the General Electric Company and the American Locomotive Company was ordered by the Paris-Orleans Railway from the Compagnie Francaise Thomson-Houston, the International General Electric Company's associated manufacturing company in France. The Compagnie Francaise Thomson-Houston has received orders for more than $15,000,000 worth of equipment for this electrification and orders aggregating $2,500,000 have been placed through the International General Electric Company with the General Electric Company in the United States.

The locomotive is of the gearless type, having two three-axle driving trucks and a two-axle guiding truck at each end. The control and auxiliary equipment is carried in two box cabs, each of which is attached rigidly to the driving truck. The three-axle driving trucks are connected by an articulated joint and each guiding truck is articulated at its inner end to the main truck. At its outer end, the forward portion of the cab is supported on a double roller centering device. The motor fields and frames are constructed to form an integral part of the truck frame and running gear and the armatures are mounted directly on the driving axles. Current is collected from an overhead trolley approximately 20 feet above the rail by means of the usual sliding pantograph, one of which is mounted on each cab. Its length over buffers is 19.02 meters (62 ft.) its total weight is 108,400 kilograms (238,480 lbs.). The average line voltage assumed will be 1,350 volts and it will have a continuous horsepower of 2,130.

The Mexican locomotive is a 150 ton, 3,000 volt, direct current type. The General Electric Company is furnishing ten of these machines for what is known as the Maltrata Incline of the Mexican Railway, a section covering about 30 miles of the most scenic country in Mexico, in which many severe grades and sharp curves are encountered. A change in 4,000 feet in elevation is made in the 30 miles section which is now being electrified.

These locomotives will be used in both freight and passenger service between Orizaba and Esperanza. Freight trains of 700 tons weight will be taken up the grade with two locomotives, one at each end of the train. Trains of about the same weight will be brought down the grade with one locomotive by regenerative electric braking. Speeds both up and down grades for freight trains will average about 15 miles per hour. These locomotives are rated 04440-E-308-6GE278A-3000 volts direct-current, of the following general characteristics and dimensions:



One of Ten Electric Locomotives Being Built for the Mexican Railways by the General Electric Company and American Locomotive Company

Electrical Data

Nominal voltage of system	3,000 volts, d. c.
Tractive effort 1 hour blown (3,000 V.)	54,300 lb.
Speed at 1 hour rating	20 m. p. hr.
Total horsepower, 1 hour	2,700
Tractive effort continuous 3,000 V.	46,200
Speed at continuous rating, 3,000 V	20.5
Total horsepower, continuous	2,500
Number of motors	6
Type of motors	GE 278 A-1,500/3,000 V
Gear ratio	90 18-5.00
Tractive effort at 30 per cent tractive coef	92,400 lb.

Mechanical Data

Track gage	4 ft. 8½ in.
Wheel arrangement	04440
Diameter of drivers	46 inches
Number of driving axles	6
Total wheel-base	40 ft. 6 in.
Max. rigid wheel-base	9 ft. 2 in.
Width overall	10 ft. 1½ in.
Height over trolley locked down	15 ft. 2 in.
Length inside knuckles	52 ft. 11 in.

Weight.

Total weight on drivers	308,000 lb.
Weight per driving axle	51,300 lb.
Dead weight per axle	12,150 lb.
Elec. and air brake equipment	130,000 lb.
Mechanical equipment	173,000 lb.

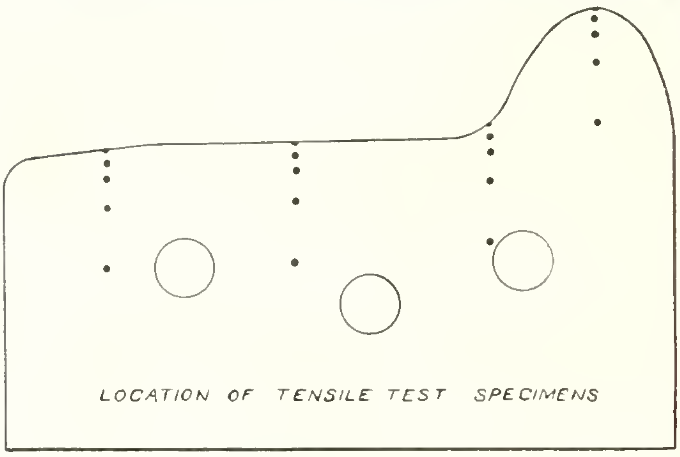
Steel Wheels—Then and Now

A Comparison of the Metals Used in the Manufacture of Car Wheels Sixteen Years Ago and at the Present Time

By Geo. L. Fowler

In the technologic papers of the Bureau of Standards, No. 235 on Thermal Stresses in Steel Car Wheels by Messrs. Geo. K. Burgess and G. Willard Quick, which was published in abstract in Railway and Locomotive Engineering for September, 1923, there was considerable data given regarding the physical and chemical properties of the steel wheels which were subjected to the tests detailed in the publication.

In 1907 Mr. Chas. T. Schoen was at work developing the rolled steel wheel, and in order to know definitely as



Locations of Photomicrographs and Tensile Test Specimens

to what he was accomplishing, as compared with the steel tired wheels at that time on the market, he had an elaborate investigation made into the physical and chemical qualities of those wheels. This was done not only for his own information, but that he might be able to present to his prospective customers a statement as to the merits of his product as compared with wheels they were using.

The steel tires examined were those made by Latrobe, Midvale, Krupp, Standard and Taylor and the steel wheels of the Standard Steel Works and the new ones that were being developed by Mr. Schoen.

The examination was thoroughly made, but the results were never made public. The accompanying cross section of a tire indicates the points at which photo-micrographs were made, and those at which the tensile test pieces cut.

The photomicrographs were made on four lines extending down to the body of the metal from the center edge. These lines were located at the point of the flange, the throat, the center of the tread and at a distance of 7/8 in. from the outer face of the rim. Vertically they were located at the edge, and 1/8 in., 1/4 in., 1/2 in. and 1 in. below the same. So that in all there were 140 photomicrographs at 87 diameters taken in the work. Of these two are here reproduced from each of the wheels and tires examined, and these represent the structure at depths of 1/8 in. and 1/4 in. below the surface of the tread.

Naturally they are closely associated with the chemical analysis of the several metals, especially with the carbon content.

The chemical analysis of these seven examples of tires and wheels were as follows:

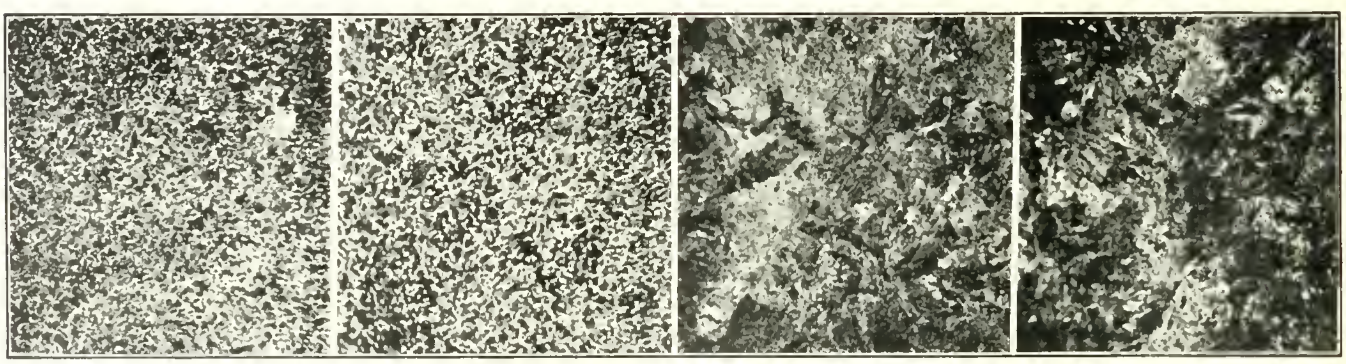
	Carbon	Sulphur	Phosphorus	Manganese	Silicon
Latrobe Tire	0.616	0.011	0.048	0.698	0.305
Midvale "	0.716	0.023	0.095	0.753	0.263
Krupp "	0.573	0.038	0.075	0.763	0.509
Standard "	0.676	0.035	0.061	0.833	0.254
Taylor "	0.631	0.042	0.081	0.775	0.241
Standard Wheel...	0.646	0.029	0.071	0.978	0.249
Schoen " ...	0.690	0.000	0.012	0.870	0.094

These photomicrographs are an interesting example of the rather rapid disappearance of the distinctive granular structure of the steel as the saturation point is approached. With the Krupp tire, having the lowest carbon content the structure is very marked and wonderfully and beautifully regular. Then comes the Latrobe and Taylor, the granular structure of the latter being coarser. The structure then almost disappearing in the Schoen wheel and Midvale tire where the carbon content is the highest.

In the case of the six steel wheels examined by the Bureau of Standards and which have been designated by the last six letters of the alphabet, the bulletin gives the following analyses:

	Carbon	Sulphur	Phosphorus	Manganese	Silicon
Wheel U....	0.67	0.019	0.029	0.77	0.19
" V....	0.73	0.015	0.028	0.73	0.21
" W....	0.66	0.014	0.027	0.67	0.17
" X*...	0.24	0.021	0.021	1.04	0.30
" Y....	0.77	0.032	0.032	.69	0.16
" Z....	0.75	0.026	0.019	.66	0.25

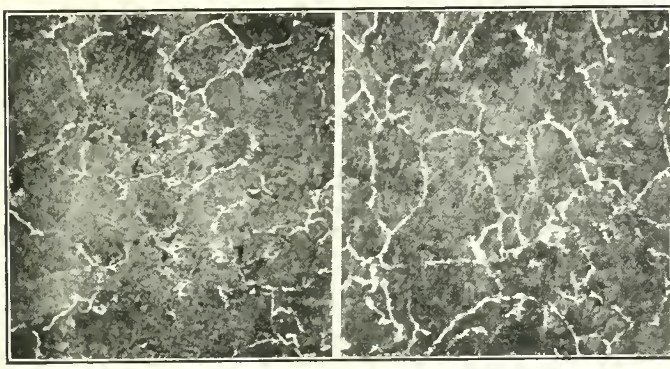
*Averages of ten analyses.



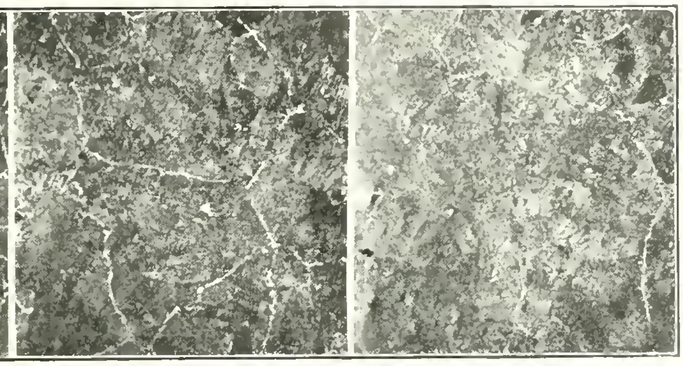
1/8 In. Below Tread — KRUPP — 1/4 In. Below Tread | 1/8 In. Below Tread — MIDVALE — 1/4 In. Below Tread

In comparing these two sets of analyses, we find that with the exception of wheel X there has been a tendency to increase the carbon content over that used in the old wheels and tires of sixteen years ago. At that time the range was from the low Krupp content of 0.573 to the high Midvale content of 0.716. Now, if we discard the apparently abnormally low content of wheel X, the range is from 0.66 to 0.77 and photomicrographs would probably show an almost if not quite complete disappearance of the structure.

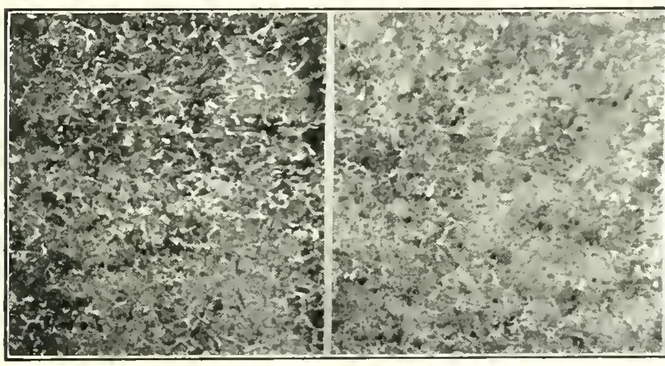
Again by excepting the Schoen wheel where the sulphur was designated at zero, the content of that impurity has been lowered by an average of nearly eight points in the new wheels as compared with the old tires. Phorphorus has been lowered from an average of 0.63 to one of 0.26. And in this it is interesting to note that, in the analyses of 1907, it was the Schoen wheel that carried the lowest percentage. Manganese and silicon have also been lowered in the new product as compared with the old.



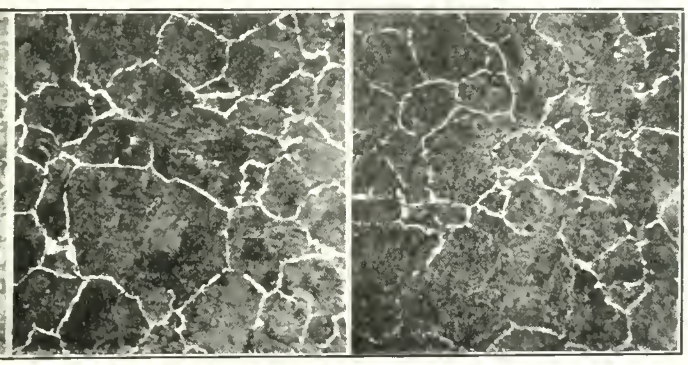
1/8 In. Below Tread 1/4 In. Below Tread
STANDARD TIRE



1/8 In. Below Tread 1/4 In. Below Tread
STANDARD WHEEL



1/8 In. Below Tread 1/4 In. Below Tread
LATROBE



1/8 In. Below Tread 1/4 In. Below Tread
TAYLOR

In short throughout the whole range, in so far as the chemical analysis is concerned, the metal of the steel wheels in use now averages better than that found in the old steel tires of sixteen years ago.

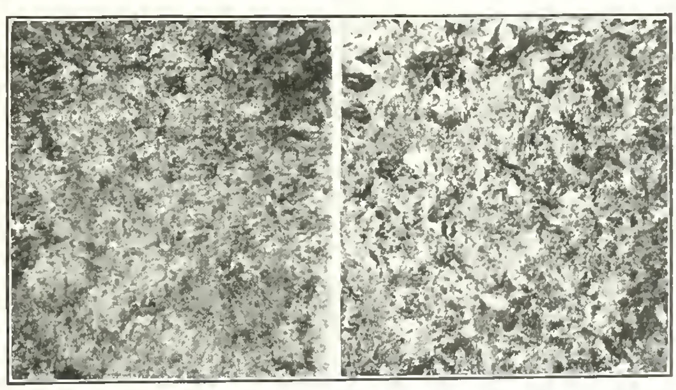
Let us now turn to the physical properties of the metal. The tests of the seven tires and wheels in 1907 gave the following results:

	Ultimate Strength, Lbs. Per Sq. In.	Yield Point, Lbs. Per Sq. In.	Elongation in 2 In., Per Cent	Reduction of Area, Per Cent
Latrobe Tire...	116,761	77,133	13.50	15.89
Midvale " ...	124,018	91,646	11.35	11.45
Krupp " ...	115,963	95,008	20.90	29.50
Standard " ...	114,915	95,232	15.40	19.33
Taylor " ...	114,477	95,580	14.90	17.13
Standard Wheel	113,610	82,388	7.40	6.87
Schoen "	124,386	104,124	8.66	12.32

According to Bulletin No. 235, the six wheels examined gave the following results:

	Ultimate Strength, Lbs. Per Sq. In.	Yield Point, Lbs. Per Sq. In.	Elongation in 2 In., Per Cent	Reduction of Area, Per Cent
U	123,300	52,100	13.5	14.1
V	119,500	———	12.5	13.6
W	107,000	43,400	13.8	14.8
X	85,000	50,700	14.5	23.6
Y	122,000	53,300	11.2	10.5
Z	130,200	61,900	11.2	13.9

Here we find a falling off in the ultimate strength of the present day wheels as compared with the old tires when the wheels are taken as a whole and only a slight increase if the weak wheel X is excluded. And only one exceeds the ultimate strength of the Schoen wheel.



1/8 In. Below Tread 1/4 In. Below Tread
SCHOEN

In the case of the yield point there is a notable loss on the part of the present wheels, the average having fallen from 91,580 lbs. per sq. in. to 52,280 lbs., or nearly 43 per cent. This has been accompanied by a slight rise in the average percentage of elongation while that of the reduction of area is about the same, but in both of these there is a marked advance over the steel wheels that were included in the 1907 tests.

Taken as a whole the metal of the solid steel wheel of today is equal to that of the old steel tires, and if the yield point can be raised it will be the superior. In this there has been a marked falling off. None of the wheels tested at the Bureau of Standards rising to that of the lowest of the tires. This may be remedied and probably will be if the tonnage demands on the mills do not block the care and attention needed to secure these results.

As it stands the solid wheel has come into its own both from a commercial and metallurgical standpoint, and that which was regarded as one of the impossibilities is now an everyday affair. That it has been of great value to the railroads goes without saying. It has not only greatly reduced the cost of wheel equipment for passenger cars but has made steel available for freight car purposes. It would be an interesting study to make a microscopical investigation of the several steel wheels upon the market in order to compare their structures as a whole with those which they have superseded and if the old Schoen is any criterion, they will not suffer by such a comparison.

Locomotive Lubrication

By W. E. Symons

In the operation of fast passenger and heavy-tonnage freight trains, the lubrication of the equipment is not only an item of importance, but essential to safe and economical operation. Comparatively little reliable data has been published on the subject, and with this in view, there appeared in our issue for May, 1923, an article in which we reviewed early lubrication practice with comments on the hydrostatic versus force feed or power lubricators for locomotives.

In our issue for July, 1923, there appeared in connection with the report of the committee on Locomotive Design and Construction of the Mechanical Division of the A. R. A., a section on Force Feed Lubrication, which emphasized the unsettled state of the lubrication question and the wide range of difference of opinion on the part of railway mechanical officials in regard to lubricants and methods of application to rolling equipment.

Under the title of "A New Language for the Steam Locomotive," in our November issue there appeared some further information on the subject, and the graphic chart of steam locomotive development showing the square inches of lubricated area or wearing surface on 24 different locomotives and accessories, from the small 17x24, 8 wheeler to the largest Mallet with cylinders 30x48x32 ins., with square inches of rubbing surface covered in 20-40-60-80 and 100 miles. The economic status of the locomotive was also brought out in a manner calculated to *not* only interest the reader, but to *arouse* or wake up those who are concerned with, or responsible for railway finances, particularly operating expenses.

We expected the articles above referred to would attract some little attention, comments, inquiries, and perhaps some criticism, and we have not been disappointed, although the tone of most all those responding has been commendatory and many railways have indicated a desire to aid us in the dissemination of information on the lubrication question.

Lubricants Required After Shopping

From data furnished us by several large railway systems we have prepared the following tabulation showing the quantities and estimated costs of the oils, greases and waste necessary to prepare different types of locomotives for road service when coming out of back shops following general overhauling, together with the estimated costs of these materials.

Quantity of Lubricants and Waste Necessary in Fitting Engines Out of Back Shop for Road Service

Classification		Engine Proper					Tender		Total Material Cost
Type	Dimensions	Valve Oil	Engine Oil	D. B. Com.	Crank Pin Grease	Waste	Oil	Waste	
8 Wheel	18x24x69	9	40	...	3	10	17	5	$3.81
10 Wheel	18x24x63	9	53	...	4	14	18	5	4.38
Switcher	20x26x51	9	39	.	4	9	17	5½	3.64
Switcher	25x32x57	14	23	120	5	3	21	7	5.97
Mogul	20x28x58	9	38	...	4	11½	17	5½	4.01
Consol'n	21x28x57	9	56	...	5	14½	18	6	6.18
Pacific	25x28x73	15	50	97	5	12	27	9	18.15
Santa Fe	28x32x57	15	36	152	7	7	21	7	24.77
Mallet	2-6-6-2	15	38	100	10	8	36	12	19.50
Mallet	2-8-8-2	15	46	180	14	13	60	20	33.37

*All quantities in pints or pounds. Labor not included.

Location of Oil Delivery

Originally all valve and cylinder oils were delivered at top of steam chest, and this was standard practice until recent years.

Increased size of engines, with higher steam pressures and superheating brought new lubricating problems, in the solution of which various plans and methods were evolved, and one of these was the point of delivery.

Some lines using force feed lubrication do not make delivery at the same point.

While most of them deliver to steam pipe or outside steam pipe, four also deliver to the *top of cylinder* barrel, while one line is trying out three different force feeds to deliver oil to the *bottom of the cylinder.*

If the general accepted theory of atomization of oil in and with the steam at a point near the steam chest, insures an equal and proper distribution of the oil to all wearing surfaces coming in contact with the steam, then the steam pipe delivery is proper and should be adhered to, while others might be classed as wrong or less efficient.

Certainly there is a *right* and a *wrong* way for doing this job, and with the life of cylinder packing rings from less than 5,000 miles, to as high as 50,000 or more, and the great expense for this item, plus loss of engine while in for repairs and its reduced efficiency on line would seem to justify more activity among the "doctors," to the end that the case be diagnosed, the disease definitely located and defined, and a remedy prescribed that will effect a cure.

The repair bill for locomotives last year was approximately $418,491,257.

The cost of all lubricants for last year was approximately $9,087,987.

The cost of lubricants was small as compared to repairs, but it must be borne in mind that in this case the *tail* wags the *dog*, and it is therefore all the more important that some standards on lubrication be established.

Snap Shots — By the Wanderer

The politicians, the demagogues, who may be one and the same, and the general reformers are all very loud in their appeals to the public to rise to protect the rights of that same dear public from the encroachments of that everlastingly convenient bug-a-boo, the railroads. When I pass in review the actions of individual members of that dear public and see the outrageous things that they do, I wonder that no man who has a craving for notoriety or even fame does not rise up and tell the dear public of what manner of animals it is composed and incidentally beg it to protect the railroads.

I was admiring the condition of an apparently new passenger car the other day in the presence of the master mechanic under whose supervision the last general repairs had been made; when the subject of the public's treatment of such a piece of property came up. It was the red rag to the bull, for he straightway launched into a tirade against the vandalism that was constantly being practiced. He stated that they had hardly a passenger car on the road whose upholstery had not been slashed with knives and ventured the guess that our car before us would prove to be no exception. And it wasn't. Sure enough there was the back of a seat with a knife cut about six inches long.

When we consider the conditions of the public toilets, especially in small towns, where a constant attendant is not employed—when we see the cigarette smoker impatient for his whiff, striking matches on freshly varnished woodwork—when we see the spitter surreptitiously ejecting his sputum upon floors and carpet—when we see litter scattered about on floors and platforms—when initials are cut in benches and walls—when we see all of these things everywhere, we can well wonder if there is any decency in that dear public as a whole about whose wrongs we hear so much.

It is one of the requirements of an equity court that plaintiffs must have clean hands, otherwise they have no case. Is it any more than fair to ask that the dear public should first learn to behave itself before its advocates shall ask favors and improvements of the conditions under which they are supposed to suffer? A fair question, but when we consider the almost hopelessness of the task of educating the individuals of the public to see themselves as others see them or as they are, the question is not apt to be fairly answered.

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The blacksmith shop is usually a disagreeable place to visit on account of the smoke and sulphur fumes that one encounters. As to the degree of harmfulness that those accompaniments of forgework possess for the acclimated workman, I am not prepared to say, but that they are not equal to good, pure, fresh air no one will deny. When I am coughing and sneezing around a shop I lose patience with the proprietor, for such a thing is totally unnecessary. In large shops of a dozen fires or upward, fans should be placed in the up-take pipes of sufficient capacity to draw the smoke and fumes into the proper channels, especially when the fire is being kindled. But smoke can be taken care of in an open fire even without a fan. Let the side and the back of the forge be sheltered by a sheet-iron screen and the top be covered with a flaring bonnet, and the smoke will go where it ought to go. This can be done without, in any way, impeding the workman. The bonnet may be telescoped into the stack so as to be raised or lowered, and two sides of the screens can be curved to slide in behind the third. If you have ever been into a shop thus equipped you will not hesitate a day to make the investment required to put your own in the same condition.

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I was tinkering on some private matters the other day, when a friend expressed an admiration for the tools which I was using, and stated that he also had a tool chest and that he always bought his tools of Snide & Co. Now I happen to know that Snide & Co. haven't a decent tool in their establishment; they sell the cheapest kind of ten-cent counter goods. I urged him to buy good tools in the future. There are more good mechanics spoiled by poor tools than poor brains. Badly made calipers are responsible for more misfits than I care to count; cheap hammers with chipped and nicked faces mean bruised hands, a roiled temper and a roughly chipped surface. These are the tools that the workman supplies for himself, and he should see to it that he has the best. If the proprietor chooses to buy cheap steel for the cold chisels that is his lookout, and he should be ready to take the consequences. But the workman sells his labor, which is supposed to be good, and he has no right to palm off an inferior article by using cheap and unreliable tools.

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A cold chisel is usually looked upon as a rough instrument of torture that anybody can make and anybody can use. Mistake; a bad mistake. Among all the tools of the shop the cold chisel ranks way up in the care required in its manufacture. I have found a strong coarse-grained but carefully made steel gives the best results. I take a coarse-grained metal because the continual hammering in use and redressing will gradually condense and remake the granular structure until it is microscopic in its fineness. Of course, in dressing it must never be heated above the cherry color and draw the temper well down so that the soft metal backs up the edge. Don't think that a multitude of grindings are what you want. You have a tool that must stand the racket of pound, pound, pound, it must cut into a distorted mass of metal, every blow gives it a wrench and a twist; every shock that it receives tends to make a new arrangement of the crystals of the metal and to make it brittle. It never gets the smooth, even crowding of the lathe tool, and so its powers of endurance must be greater. Then after the day's work is done it is dumped like a piece of scrap into a drawer filled with rubbish and the like. A well made cold chisel is a nice tool, and when properly driven is capable of turning out work that would surprise those who are unfamiliar with its possibilities. But as you can't make a silk purse from a sow's ear you cannot make a good chisel from poor, cheap steel.

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Speaking of cheap steel, it is strange how the bargain-counter instinct is in some people. I was away off in the country some years ago and in want of some files and cold chisels. The proprietor of a hardware store had just what I needed. He knew he had for all the farmers and quarrymen used it. I selected what I wanted and asked the price. Five cents per pound for the best quality of tool steel. As I couldn't wait, I invested. I think that a high grade brand would have cost less at five dollars a pound. Most of that steel passed down into the water beneath the grindstone. The edges of the chisels simply would not hold their own. Yet there were hundreds of men making a good business for the dealer in the stuff because they wanted the lowest-priced article that could be procured, and if he had not given it to them they would have gone elsewhere.

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Locomotive Development

When three of the most prominent locomotive men in this country reached the conclusion in the winter of 1881 that the locomotive had then reached the limits of its possible development, it simply meant that they had bumped their heads against an imaginary wall, and were stopped because they thought they were and not because of the existence of any actual obstruction.

It would have been difficult for any engineer, in the early eighties, to have visualized the locomotive of forty years later, and not the least of the handicaps to such a visualization was the fact that many of the materials that contribute to the locomotive of today were not available at that time.

The experience of the last few decades has taught engineers to be very wary of any expression of opinion to the effect that the limit has been or will soon be reached. That this wariness has a sound basis of fact is shown by the contents of this and recently previous issues of this paper.

A number of years ago we were treated to an influx of freak constructions such as the Fontaine, Raub, the double-decker of the South Jersey, and the flat spot Shaw. But since that epidemic has passed we have heard little or nothing of such constructions. In their stead has come a normal growth and development. The half-stroke cut-off of the Pennsylvania has evidently seated itself firmly in the saddle of the present company. The booster is a healthy youngster, with bright prospects and a future still to make for itself. The New York Central three-cylinder simple is giving a good account of itself, and Mr. Muhlfeld is pinning his faith on a two-cylinder cross compound, a type with which we were familiar and the pros and cons of whose merits and demerits received a world wide discussion twenty-five years ago. But Mr. Muhlfeld's engine is of an entirely new design employing high steam pressure.

Then we have the steam-electric engine still in the experimental stage; a favorite with experimenting engineers ever since the days of the Heilmann locomotive of twenty-six years ago, and giving more and greater promises of final successes with every reincarnation.

Surely there is no lack of development going on and likely to continue going on into the far indefinite future. What will be the final development is impossible to say. That they will be many is altogether probable, each suited to its own particular sphere. It is also more than probable that they will differ as radically from the common locomotive of today as the Mallet does from the old eight-wheeler of the early eighties. Man has been thinking hard about the locomotive for a hundred years, and another century of the same sort of thinking will produce something tremendously worth while.

Why Derailments?

If anyone were to compare the track in use at the time of the ten-ton car in capacity and weight with that of the present day, it would hardly seem possible that the two were intended for the same purpose, so great has been the change between then and now. Then, there was no such thing as a split rail switch, a splice bar or a tie plate. The last item had not been dreamed of; a cast iron chair served for the splice bar and the stub switch was in universal use, while a fifty pound rail was as heavy as was needed.

It does not need a very vivid imagination to picture to oneself the condition such a track would be left in, if it was to be traversed at even the lowest speeds by a heavy locomotive of the present day While if an attempt were made to run a modern train over it at its accustomed speed the distance so run before a derailment would occur would be short indeed.

The attitude of the track and equipment departments of a railroad towards each other may be likened, in a way, to that of ordnance and armor plate. When the shell can pierce the armor, the armor is improved to withstand the impact, and then the shell is improved so as to pierce the new armor. When the track cannot sustain the stresses imposed by the rolling stock it is strengthened so as to be able to do so; which, in turn, seems to warrant a further increase in the weight of the rolling stock.

Still whenever there is a derailment, each department points a finger at the other and says: "Thou art the man," and each retorts with, "Thou canst not shake thy gory locks at me and say I did it."

Now we all know that derailments occur both because of defective equipment and because of defective track. But when there is an epidemic of derailments the probabilities are that the responsibility can be definitely located on some one cause, either the rolling stock or the track. If the derailments are localized, that is occur at certain places, it is fair to assume that the track is at fault. If they are scattered over the whole line, it may be track or rolling stock.

It has so happened, however, that an increase in the capacity of cars or the weight of locomotives has been followed by a series of derailments, until the track was rebuilt. This occurred when car capacities were increased from ten to twenty tons, again when they were raised to thirty, again at forty, fifty and seventy. Sometimes a modification was made in the truck construction of the new cars, but more often the increase in track strength, surface and alinement served the purpose.

In one case a new type of locomotive was introduced, and shortly afterwards there was a bad derailment in which a number of passengers were killed, and the accident received a nation-wide publicity. An investigation showed that these particular locomotives put an exceptionally heavy lateral stress upon the track. As a remodeling or change of the design was considered inadvisable, the track was brought up to the requirements of the case, and, as one engineer expressed it, made as strong as the redoubt of a battleship. And so it stands and there have been no more derailments.

It is interesting to note, too, that where track stresses have been measured, it has been found that the excess stress occurs at the same place, regardless of speed.

All this simply means that, when a new class of rolling stock is introduced and derailments of it follow, it is well to look to see if the track is up to the new requirements that are put upon it, as well as to look carefully to the vehicle to make sure that it has the strength and flexibility to go where it is expected to go, carry the load that is expected to carry and run at the speeds at which it is expected to run. For if either track, car or locomotive is lacking in its essential requirements, we must expect derailments to follow, and it is a wise management that keeps its track ahead of the demands put upon it by its traffic.

Libeling the Railways

The tendency to unjustly blame the railways for most all economic ills has become so general in recent years that few communities, if any, have escaped its blighting effect.

One of the stock answers of most all tradesmen and merchants is that, if railroad rates were not so outrageously high, goods, commodities, materials, etc., could be sold at greatly reduced prices, in fact, the freight rate is not infrequently represented to be the principal item on which the dealer bases cost, and from which he seeks relief.

As an illustration of the absolute falsity of many of these claims, we invite the attention of our readers to the following incident.

An investigator of problems of this character visited a thriving town in Missouri, and as result of talking with all classes of people including farmers, he found it to be the general belief that railroad rates were too high and about all that stood between all classes and a big business boom was a drastic cut of at least 20 to 30 per cent in freight rates. After a pretty thorough canvas as to the general sentiment and sources from which propaganda came, our investigator went into one of the leading stores, kept by an old resident long in business there, who had much influence in the town and surrounding country, and asked to be shown some gloves. It so happened that the proprietor waited on the prospective customer, who after examining the gloves inquired the price, and was informed $2.40 per pair. "Isn't your price a little high on that article?" the prospective customer inquired.

"Yes," says the proprietor, "it is too high, but I am forced to charge that price on account of the high freight rates. The railways *rob us* and we just put it on the selling price and pass it on to the ultimate consumer. If we could get a 20 per cent reduction in freight rates I could sell you that glove for less than $2.00 and make more than I do now at $2.40, and that's what we are going to get when the next Congress meets."

"Where do you buy these gloves and what freight rate do you pay on them," inquired the prospective customer, to which the proprietor replied, "They are made in Knoxville, Tenn., and the manufacturer pays the freight. I don't know the rate exactly, but I do know that it is on this account my selling price is so high," etc.

The prospective customer who was actuated by an ulterior motive in his negotiations for the gloves, says "Now my friend let me tell you something, you are all wrong on this rate question, and you are no doubt the cause of many others preaching this insidious propaganda against railways.

"The freight rate on gloves from Knoxville, Tenn., to this point is $2.00 per 100 lbs. and in each 100 lbs. there is 24 dozen pairs of gloves; figure it out yourself. The cost of transportation to bring one pair of gloves from Knoxville, Tenn., to your store is exactly 6.94 mills, or less than *three-quarters of one cent*, and a 30 per cent reduction in freight rates would reduce this wonderfully outrage charge all of one and ninety-eight hundredth mills (1.98 mills), yet with all these facts easily within your grasp you look me in the face and say that with a 20 to 30 per cent reduction in freight rates you could *easily* and would *gladly* reduce your selling price more than 40 cents."

The merchant was at first angry, because he stood committed to this iniquitous doctrine and didn't really want the facts, as he had allowed himself to believe some of it was true. He was then astounded to learn how foolish he had been, and how unfair to the railways, and then and there resolved to leave no stone unturned in his efforts to undo the wrong done.

Something for Nothing

It is generally understood that the patent office will not grant an application for a patent for perpetual motion, on the ground that the idea so violates the fundamental principles of physics as to be impossible of execution.

The post office is very severe upon those who use the mails for fraudulent purposes, and the most common of such fraudulent purposes is the promising of something for nothing. Mathematicians deal very clearly with minus quantities, but before they get through with their calculations they like to get a result with a plus sign before it.

It seems, if report be true, that a certain Senator of the radical group has embarked upon a course that promises great profits to the people of this country with little or no effort. A course that looks as though it were a cross between a design for a perpetual motion machine and the extraction of a very substantial something from nothing. He proposes, if he has made himself clear, to secure a revision of freight rates based on the actual valuation of the railroads after he has squeezed $12,000,000,000 not worth of water, but as represented by him as water out of the $10,000,000,000 value of the property as represented by him as it stands. Just how he is going to do it remains to be seen. Possibly, he proposes to substitute senatorial hot air for what he calls railroad water. But one thing is sure that the public would be far better off submerged in the cold water of railroad securities than when smothered in the hot air of senatorial outbursts.

There was once a great railroad magnate who had for a son-in-law an editor of a widely circulated daily newspaper. On one occasion the magnate expressed his opinion of his son-in-law by saying that he (the son-in-law) was more kinds of a damned fool than any other man alive.

Value of Failures

There are some kinds of mistakes that human nature insists in repeating and no amount of experience of others will prevent constant repetition. It seems to us that railroad men ought to be willing to show up some of their mistakes, just to keep others out of the same pit and for the general information of the craft. The thing does not, however, work in this way. We recently visited a railroad shop with a friend who had long experience as a master mechanic. The general foreman of the shop showed us a device he had half completed for turning up crank pins. When we got into the street my friend said, "That pin turnover won't work, I was all through that ten years ago." Then he gave a good reason why it failed, and showed where the invention was at fault.

When asked why he did not put the inventor "on" he said that he learned by experience, and that the latest inventor might do the same and then he would see when to stop. That seemed to me a very selfish stand to take, but it is very common.

We can only find whether or not a device or process will work by trying it. When a man gets up a thing that works, we hear all about it, and frequently use his idea and unusually pay him for it, but when he gets up a thing that won't work he keeps mighty still about it. Every person of an inventive turn produces many things that don't work, but they give him useful information.

Speaking of Good Resolutions

The Dixie Railway Club of Mobile, Ala., recently passed the following resolutions which we commend to the readers of Railway and Locomotive Engineering:

WHEREAS, the American Railway Association and the railroads collectively and individually, have resumed their efforts to lessen the number of deaths and injuries at railroad-highway crossings at grades throughout the country; and

WHEREAS, in five years 9,101 persons were killed and 24,208 were injured at railroad-highway crossings in the United States; and

WHEREAS, there are approximately 13,500,000 motor vehicles in the United States; and

WHEREAS, there are 251,000 railroad-highway crossings at grade on Class 1 railroads alone, the removal of which at the present rate of 485 per year would require over 500 years at a total expenditure of more than $12,500,000,000 to eliminate;

BE IT, THEREFORE, RESOLVED by the members of the Dixie Railway Club that we will, when driving any motor vehicle, cause it to come to a full stop within a reasonable distance from all railroad-highway crossings at grade; and

BE IT FURTHER RESOLVED that when riding in a motor vehicle driven by another, we will use our influence upon the driver to cause the car to be stopped as above; and

BE IT FURTHER RESOLVED that before employing any individual with a motor vehicle to transport ourselves or members of our families we will request this common care, and patronize only those who comply with such request.

Chamber of Commerce of U. S. Recommends Coordination of Transportation Facilities

A comprehensive plan for linking organized motor transport with the railroads in the development of a balanced national system of transportation is outlined in the report of the Committee on the Relation of Highways and Motor Transport to Other Transportation Agencies submitted November 13 to Julius H. Barnes, president of the Chamber of Commerce of the United States.

Changes in prevailing methods of handling and distributing freight are proposed. Store-door collection and delivery to relieve congestion within the crowded terminal areas of large cities, the use of organized and responsible motor transport to relieve the railroads of various forms of uneconomical service, including the unprofitable short haul, are recommended.

To pave the way for these changes in the public interest the committee suggests the regulation of common carrier operations of motor vehicles by the federal and State commissions which have supervision of rail and water carriers, and the systematic development of highways in response to general traffic needs.

Among the conclusions reached and recommendations made are the following:

"The best interests of the public and the rail, water and motor carriers lie in co-operation between the various agencies of transportation rather than in wasteful competition.

"The greatest opportunity for co-operation is at the points where the capacity of the railroads is most limited and expansion is most difficult and costly; that is, in the terminal areas of our great cities.

"Store-door delivery by motor truck, which would relieve congestion in these terminal areas and greatly increase the capacity of the freight stations, is undoubtedly the greatest contribution which can be made to the solution of the terminal problem.

"Organized motor transport can also relieve the railroads of various forms of uneconomical service, such as trapcar service, switching between local stations and short-haul shipments within the terminal area. This will reduce yard congestion and release many cars for more profitable line haul.

Economic Limitations to Each Form of Transportation

"It is to the public interest, as well as to the interest of the respective carriers, that the economic limitations of each type of carrier be recognized, that the railroads be permitted to discontinue unprofitable service to which the motor is better suited and that the motor abandon its efforts to handle general traffic over excessive distances. However, because of the public interest which affects the operation of railroads, they have performed and must continue to perform some service which is unprofitable, chiefly in territory where the performance of highway transportation would also be unprofitable. If the railroads are to be deprived of a substantial share of their more remunerative traffic through unfair and, to the trader, uneconomical methods, the traffic remaining to the railroads must take on an added burden in the form of higher rates or impaired service. In all cases where the railroad can handle traffic with greater or equal efficiency, all factors being considered, the public interest requires that it be allowed to do so. Unprofitable steam railroads' service can in some cases be successfully replaced by the use of self-propelled railroad motor cars.

Regulation of Motor Freight

"Regulation of traffic and of size, weight and speed of motor vehicles by states and municipalities having control should be made more uniform within states and as between states. Regulation of common-carrier operations of motor vehicles, including rate regulation, should be handled by the federal or state authorities, under the commissions which now control the operations of rail and water carriers.

"The congestion of transportation," the committee continues in its report, "today centers around the terminals of our great cities, and it is at these terminals that the railroads find the greatest difficulty in keeping pace with the public need. With hardly an exception the main tracks of our railroads have sufficient capacity for the movement of more freight than can be offered to them. With hardly an exception the railroads are constantly faced with a demand for more and better terminal facilities in the face of prohibitive real estate values and other stupendous obstacles to expansion. Here lies the greatest opportunity for the motor truck. By the use of motor transport the facilities of the terminals can be so expanded as greatly to increase their capacity.

"There are three principal directions in which the motor truck can serve to relieve the terminal situation:

"1. By organized cartage instead of the present go-as-you-please methods of receipt and delivery at the rail terminal; further than this, by the store-door delivery, which is real completed transportation.

"2. By substitution of motor service for a part of the rail service.

"3. By complete elimination of certain rail service. This would cover intraterminal movement, such as movement between industries or different plants of the same industry within the terminal area, which would then be handled by motor truck."

President of B. & O. Discusses Transportation Act in His Report to Stockholders

In his annual report to the stockholders of the Baltimore & Ohio Railroad, Daniel Willard, president of the company said:

"You will, of course, appreciate that no one can speak with definiteness concerning the future, but there is now reason to believe that in the absence of abnormal conditions, dividends on Baltimore & Ohio Common stock will be maintained. Of course, the ability of the Baltimore & Ohio Company to earn and pay reasonable dividends upon its common stock will depend not only upon business conditions generally, but also to a very considerable extent upon the system of regulation under which we operate. At the annual meeting two years ago I ventured to make the following statement:

"'I feel confident that if the Transportation Act of 1920 is left in its present shape until the railroads have had time and opportunity to give the law a fair trial, that we will be able, slowly perhaps, but certainly be able, to work out of our present difficulties, and I hope under the terms of the present Transportation Act to see railroad securities once more restored to the confidence of the investing public. While the Transportation Act of 1920 does not afford a perfect or final solution of the railroad problem, it is in my opinion distinctly in advance of anything which we have heretofore had in that direction, and to my mind the Act, even in its present shape, is susceptible of being so applied as to measurably if not fully meet the requirements of the situation. In any event, I think it ought to be given a fair trial before any attempt is made to materially amend it.'

"I see no reason now for changing the views which I then expressed, and I think the operating results of your company for the present year confirm my former statement. I still look upon the Transportation Act of 1920 as a very constructive piece of railroad legislation, and while undoubtedly it may have defects, I am confident that the real interests not only of the railroads, but of the country as a whole, will be best promoted at this time by leaving the Act as it is until it can be given a more thorough trial under conditions of a more stable character. If the Act is left in its present form, and if business continues on the basis we now have a right to expect, it seems to me that the outlook for Baltimore and Ohio stockholders is distinctly encouraging, and I say this not unmindful of the fact that in 1925 the company will have to arrange for the refinancing of a large amount of outstanding bonds which mature at that time and which now bear a very low rate of interest.

"As owners of the Baltimore and Ohio property and as citizens interested in the welfare not only of the property but of the country as a whole, I think you should urge your representatives in Congress to resist the demands which will probably be made in certain quarters for radical changes in the Transportation Act."

American Railways Perform Twice the Service Per Dollar of Capitalization that Foreign Systems Render

The people of the United States have reason to be proud of their railroad systems and their accomplishments, according to Julius Kruttschnitt, chairman of the Executive Committee of the Southern Pacific, who says that with 6 per cent of the world's population this country possesses nearly 40 per cent of the world's railroads. The American railroads, he says, are capitalized at only from one-quarter to one-half as much per mile as those of the principal countries of Europe and charge the public rates only one-half as much per mile of movement.

In an address before the Railway Business Association Mr. Kruttschnitt developed this point, saying in part:

"At the same time they perform twice the public service per dollar of capital invested.

"Take 1920 as a basis of comparison. The railroads of the United States in that year handled 32.71 traffic units [which the Interstate Commerce Commission equation calculates as ton-miles plus three times passenger miles] per dollar of capitalization with average receipts per ton mile of freight of 1.052 cents.

"In other words, a ton of freight was moved practically one mile for the price of a one-cent postage stamp.

"The railroads of the United Kingdom handled 8.24 traffic units per dollar of capitalization, with average receipts per ton mile of 3.029 cents.

"In South Australia 10.95 traffic units were handled per dollar of capitalization, with average receipts per ton mile of freight of 3.62 cents.

"In New South Wales 15.67 traffic units were handled per dollar of capitalization, with average receipts per ton mile of freight of 2.49 cents.

"We have been unable to find any data conflicting with the assertions frequently made that the United States has the most abundant and cheapest rail transportation in the world."

Mr. Kruttschnitt's figures on foreign currencies were reduced to American equivalents at the normal rates of exchange.

Decreased Passenger Traffic on Russian Railroads

Passenger traffic on the railroads of Soviet Russia reached its greatest monthly volume (under the Bolshevist régime) in October, 1922, when a total of 9,752,000 passengers were carried, and declined to 6,428,000 passengers carried in January, 4,482,000 in February, and 5,299,000 in March, 1923, according to the latest statistics of the commissariat of transport, as published in Economic Life, of August 18. The total number of passengers carried on Russian railroads in 1913 was 262,967,500, or an average of 21,914,000 per month.

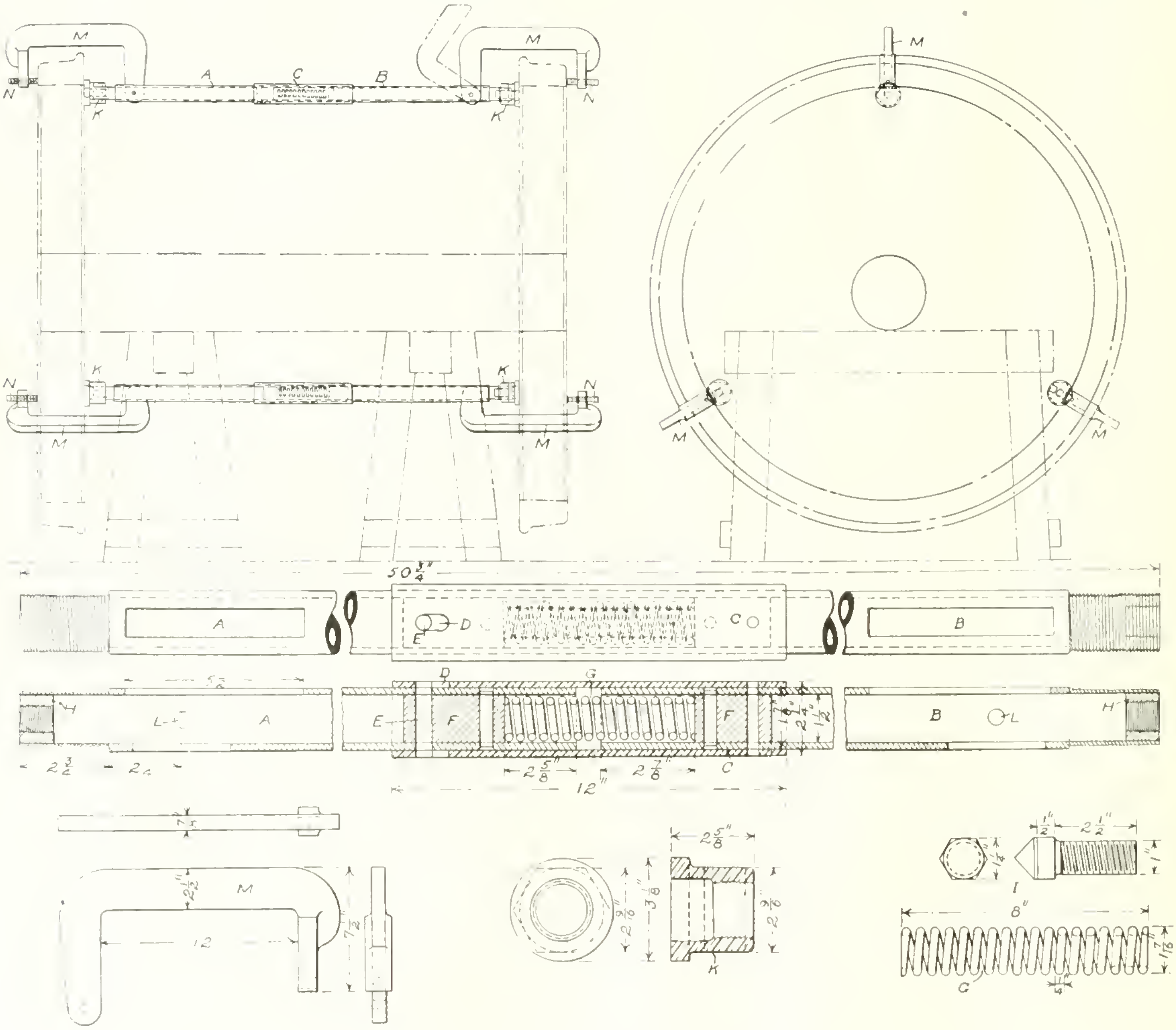
Shop Kinks

A Collection of Useful Tools Originating and in Use in the Shops of the Chesapeake & Ohio Ry.

Gauge for Setting Locomotive Tires

This gauge is used for adjusting the tires on the centers when they are being shrunk on. Trouble has been experienced with the ordinary rigid gauge in that it is apt to be caught and cramped when the tire has cooled. This occurs because the spokes of the center are dished and, as the tire shrinks, the dished spokes yield under the stress imposed, so that when a rigid gauge is placed side of them is utilized to hold the spring *G*. The outer ends of the two pieces *A* and *B* are threaded to receive the nuts *K* and also have the bronze nuts *HH* welded in. These nuts are threaded to take the center *I*. A bolt hole *L* is drilled 5 in. from the end of each piece *A* and *B* to carry one end of the yoke *M* as shown in the engraving of the assembled parts.

The method of using the gauge is first to apply it to



Details of Gauge for Setting Locomotive Tires

between the tires, when they are hot, it is pinched as they move towards each other in cooling.

This gauge obviates this difficulty.

The two main pieces *A* and *B* are made of hydraulic pipe united by the coupling sleeve *C*. This sleeve is rivetted solidly to the piece *B*, but is made with a sliding fit over *A*. At the *A* end of the sleeve there is a slot *D* in which a pin *E* can move towards the center of the gauge [illegible] in. The plugs *F* are rivetted in the pieces *A* and *B* a short distance from the end, and the space out- the wheel centers. In this the centers *I* are sprung into place with the yokes *M* turned back out of the way, as indicated by the dotted lines at the right of the assembled engraving. The nuts *K* are adjusted so that, when the tires are brought against them hot there is a proper allowance made for the yielding of the center. The tires are drawn in against these nuts *K* by the set screws *N* in the yokes *M*.

When the tire is placed over the center it is adjusted by the set screws and allowed to cool. As the center yields under the pressure of the tire the spring *G* permits the ends of the gauge to yield also, so that it is not pinched or distorted by the movement. Then, when the tire has cooled, it is readily removed.

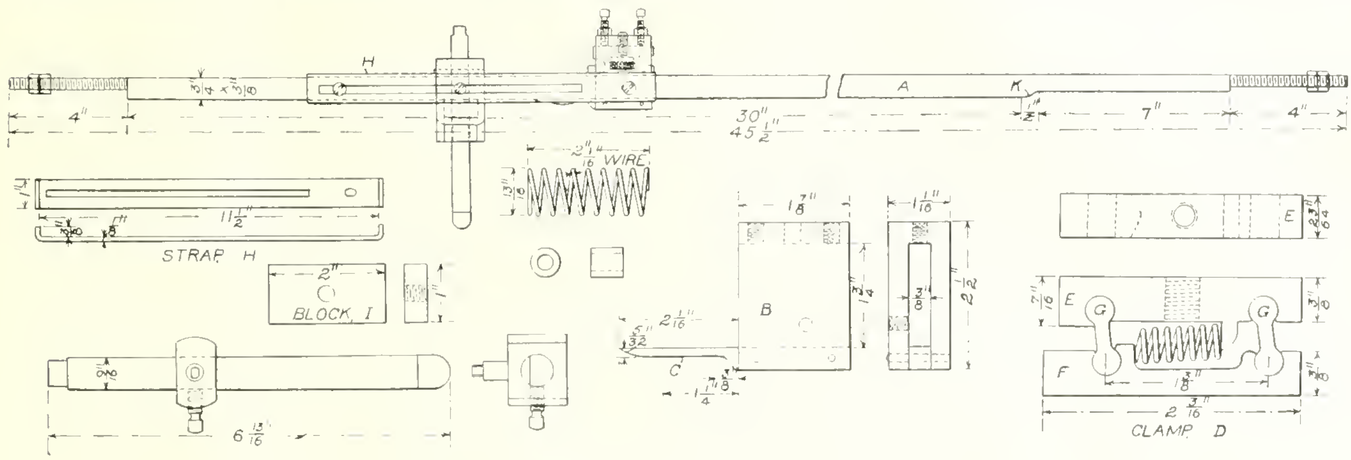
By the use of three of these gauges the tires can be set true on the centers.

Staybolt Dethreading Device

This arrangement is one that was designed and patented by Mr. S. L. Gary, foreman of the Seventeenth Street Shops at Richmond, as an attachment to the Lassiter staybolt machine. It takes the place of the strips that were formerly used, and of which one was required for each length of staybolt. Its advantage over the original arrangement is that it is universal in its application and lips over the right hand side or bottom of the head *B*, is fastened to it, and serves to raise it. The other end lips over a block *I* and is fastened to it by a tap bolt passing through the long slot, and can thus be set at any desired distance from the head. This distance regulates the length of thread on the upper end of the staybolt, as it is placed in the machine, which is to be left untouched.

With this adjustment made the tool holder is raised to the upper end of the bolt and when its pin strikes the block *I*, the strap *H* draws the head *B* after it at a constant distance behind the tool.

When in this position the tool is drawn back from the staybolt and no cutting occurs. It will be remembered that the head *B* is now firmly clamped to the stem



Dethreading Device for Lassiter Staybolt Machine

can be used for the dethreading of any length of bolt, and is put in the same place as the old guide strips.

It is formed of a bar *A* of ¾ in. by ⅜ in. steel that is of the shape shown. The tool holder is not carried by the strip as it appears to be in the drawing, but occupies a regular place on the machine and is attached to the dethreading stem *A* by a slide.

The guide that controls the movement of the tool in and out of the work is shown in detail. First there is the head *B*, which is of bronze and slips over the stem. In the open end of its jaw the steel tongue *C* is fastened by taper pins. This head is automatically clamped to the stem by the clamp *D*, which consists of two bars *E* and *F* that are held parallel to each other by the connections *G* in the same manner as the bars of a parallel ruler. A spring abutting against a lug projecting from the bar *E* and a shoulder on the bar *F* tends to move the latter to the left and thus increase the distance between the two sides of the bars. It is evident then that when the bar *E* is fastened to the head *B* by a tap bolt, the spring will throw the bar *F* against the stem *B*. If an attempt is then made to move the head, so clamped, to the left, it can be done because the friction will tend to move the bar *F* to the right, as shown in the detail, which will compress the spring and the bar will swing on the connections *G* away from the stem. But if an attempt were made to move it to the right the friction will tend to move the bar to the left and together with the tension of the spring, will swing the bar on the connections and clamp it more firmly to the stem.

The head can thus be easily moved to the left, but not to the right unless the pressure of the parallel bar *F* on the stem *A* has been released. In placing the device in the machine, that end shown at the left is at the top and that at the right, at the bottom.

The tool holder has a bearing on the stem and a pin sliding in the slot of the strap *H*. One end of this strap by the parallel bars. The tool then moves down for the proper distance, without touching the threads of the bolt until its slide comes in contact with tongue *C* on the head. The slide rides up on this head and the tool starts removing the threads. In the meantime the head has been stationary.

The tool cuts away the thread and the slide moves down until it strikes the end of the parallel bar *F*. This it easily pushes down (to the right on the engraving) and unclamps the head from the stem and continues to push it down until it reaches the offset at *K* on the stem. The head and the tool post then move away from the staybolt and the dethreading ceases. This offset is placed at a proper distance from the end of the stem to leave the desired amount of thread at the lower end of the staybolt.

Shear for Squaring Ends of Staybolts

The squaring of the ends of staybolts by which they may be screwed into place is somewhat expensive when it is done either under a hammer or on a machine. A quick and economical method has been developed on the Chesapeake & Ohio, by which they are squared by a special shears, adapted to be placed on an ordinary Long and Alstatter punch and shear. There is a base *A* attached to the anvil of the machine. This base carries two V supports *BB* and back of these are the two flat topped supports *CC*.

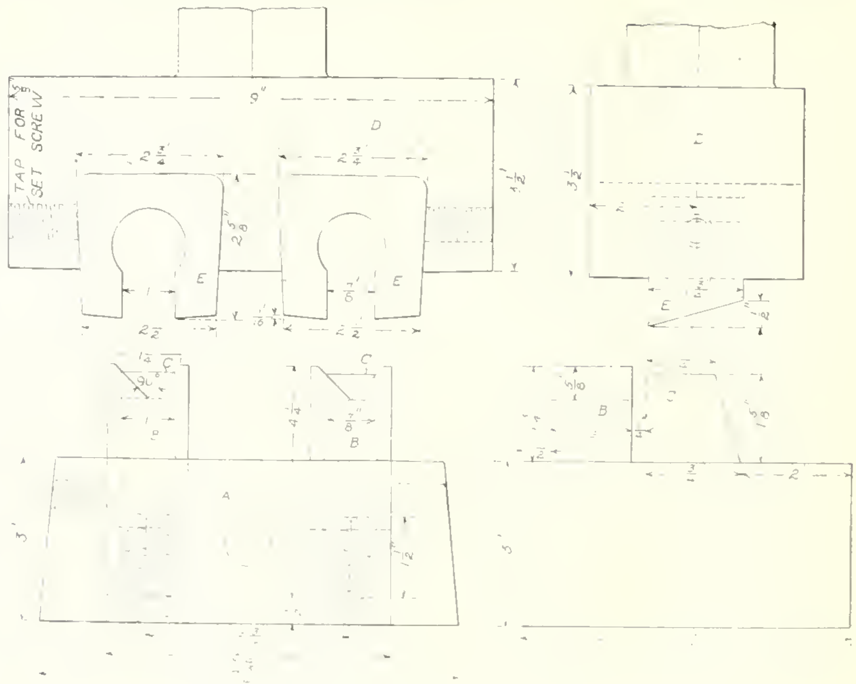
The V supports are held up by springs, which yield under the pressure of the cutting.

The head *D* is fitted to the moving head of the machine and carries the two cutters *EE*. These are double cutters and have an opening of 1 in. and ⅞ in. respectively, and are used according to the width of the square that is to be cut. These cutters come down and straddle the flat topped supports *CC*.

In action, the round staybolt is placed in the V supports when the cutters are up, with the end projecting over the flat-topped supports by a distance equal to the length of square that is to be cut. As the cutters come down the V supports yield until the bolt rests on the flat topped one, and, at the same time, prevents it from turning or getting out of line. The cutters then shear off two sides of the bolt. When the cutters have risen the bolt is turned with the flat first formed resting on the support C, which holds it square while the V support keeps it in line for the second cut.

With this arrangement the bolts can be squared, a cut being taken with each stroke of the machine.

It will be seen that the cutters have considerable rake to the back, and this with the lesser side rake makes it possible to shear off the round of the bolt with a clean cut leaving a smooth square; and, at the same time, do no injury to the threads at the end of the cut portion. They are, therefore, left in perfect shape to be screwed into the sheets and need no further attention.



Tool Used for Squaring Ends of Staybolts

A New Record for Locomotive Repairs

The Southern Pacific Company recently established a new record at their El Paso, Texas, shops of the Atlantic System in the general overhauling of one of their Mikado type locomotives in the record breaking time of nine eight-hour days or a total of 72 hours.

The engine went into the shop at 7 a. m., September 15, for what is known as "class two" repairs—a new fire box, flues and general machinery repairs, including all tires turned or new.

The engine was out of the shop and approved for service at 4 p. m., September 25, a total of 11 days. In that period there were two Sundays, when no work was done on the engine, making a total of nine eight-hour working days, or 72 working hours.

Almost every man in the shops had a part in establishing this record, which may be the fastest work of this type ever done in the entire country.

In addition to breaking the speed records, the project put the facilities of the new erecting shop to a test that proved satisfactory.

The average idle time of locomotives on our railways is entirely "too high" both when under repairs and in the hands of transportation department, and while some lines have shown improvement in both items, no company, so far as we have information, has as yet given a locomotive a general overhauling and returned it to revenue earning service in nine (9) days.

The Southern Pacific people at El Paso, Texas, therefore, seem to hold the record at present for efficiency in maintenance and it is hoped others may pull up somewhere near this performance.

In the view of the locomotive, reproduced herewith, the group are Master Mechanic William Bleick and his staff. Reading from left to right the individuals are: A. M. Berryman, boiler foreman; H. T. Creps, erecting shop foreman; F. A. Thorp, assistant boiler foreman; M. Poll, machine foreman; C. E. Barrow, carpenter foreman; C. Windberg, labor foreman; C. E. Vogel, lead man; H. A. Conner, tool foreman; J. A. Snowden, paint shop foreman; D. B. Herbert, general foreman of shops; William Bleick, master mechanic; F. C. Luschei, blacksmith foreman; W. Goode, foreman electric shop; Z. Perez, apprentice instructor; F. R. Patterson, third shift roundhouse foreman; J. P. Donnelly, first shift roundhouse foreman; S. J. Hockett, drop pit foreman; R. A. Bogel, foreman air department; W. L. Congdon, second shift roundhouse foreman; H. W. Farenthold, pipe shop foreman; F. H. Ehrenstein, inspector.

Master Mechanic W. Bleick and His Staff Standing Beside Mikado Type Locomotive, Overhauled in Record Time at the El Paso Shops of the Southern Pacific

Welding in Locomotive Repair Shops*

Various Oxy-Acetylene Welding Operations Employed in Locomotive Repair Work

By Fred E. Rogers†

Locomotive maintenance and general repairs have undergone considerable change in method within the past decade as a result of the introduction of the newer welding processes. It is indeed fortunate for transportation interests that gas, electric, and thermit welding have become available. If old-time railway shop practice had prevailed during the shopmen's strike in 1922-1923, the numbers of locomotives out of service on the railways affected would have been still greater than they were. A recent survey of locomotive-shop practice, made by a railway service engineer on one of the large railway systems, showed over one hundred welding operations practiced in locomotive repair work. This survey, made in the interest of oxy-acetylene welding only, does not include those operations which were considered as being better fitted perhaps for the electric-arc or the thermit process.

The intelligent and honest welding engineer frankly concedes that the particular welding process which he represented may be at a disadvantage in certain cases with other processes, considering cost, feasibility, or application. There is plenty of room for the development and use of each, and the best interests of all concerned are conserved by recognizing the advantages and limitations of any particular process. This paper is not offered as an argument for oxy-acetylene welding only because the author is interested in promoting gas welding, but is simply an endeavor to point out in an unprejudiced way how the officials responsible for locomotive maintenance have profitably employed gas welding (oxy-acetylene) in locomotive repair work. What has been done and is being done by an increasing number of railway systems, can be done with equal benefit by all.

Locomotive Parts Repaired by Oxy-Acetylene Welding

Following is a list of locomotive parts that are repaired by oxy-acetylene welding. This list by no means comprehends all. On the other hand, it includes some parts that under certain conditions should not be repaired by gas welding or by any other welding process. It is a well-known fact that many machine parts can be replaced with new at a cost less than that of the repair of worn parts. This applies to some locomotive parts in principle, but owing to the multiplicity of types and lack of interchangeability, there are few repair shops having storerooms from which they can draw new parts for all minor repair jobs to which this general statement might apply. Hence, in many cases, repairs are made because the new parts could not be obtained without laying up the locomotive for several extra days.

List of Locomotive Parts Repaired by Oxy-Acetylene Welding

Air-brake cylinders, broken and welded.
Air-brake pistons, worn part built up.
Air-pump valve housings, welded.
Air-pump heads.
Air-pump cylinders.
Air-pump lugs.
Air-pump brackets.
Air-pump pistons, built up.
Air-reservoir heads, welded in.
Air-reservoir brackets, broken and welded.

*Paper presented at Chattanooga Regional Meeting of the American Society of Mechanical Engineers.
†Air Reduction Sales Co.

Ashpan castings, broken and welded.
Ashpan corners, welded.
Bells, cracked and welded.
Bell stands, broken and welded.
Binders, built up and welded.
Brake hangers, holes welded; and broken and welded.
Brake-hanger pins, built up.
Brake adjusters, broken and welded.
Brake beams, ends built up.
Back-head patches, welded.
Brake-rod jaws, broken and welded; holes welded.
Branch pipes, brazed; broken and welded.
Casing-sheet patches, welded.
Cast-steel tank frames, broken and welded; cracked and welded.
Cast-steel truck frames, broken and welded; cracked and welded.
Couplers, welded.
Coupler pockets, broken and welded; cracked and welded.
Coupler knuckles, worn part built up.
Crossheads, pin fits, welded.
Crosshead lateral, welded.
Crosshead piston fit, worn part built up.
Crosshead cracks, welded.
Cylinders, welded.
Cylinder heads, welded.
Door-sheet patches, welded.
Drawbar pockets, broken and welded; cracked and welded.
Driving boxes, broken and welded; cracked and welded.
Driving-box collars, broken and welded; cracked and welded.
Driving-wheel spokes, broken and welded; cracked and welded.
Driving-wheel tires, built up (sharp flanges and flat spots).
Dry-pipe joints, brazed.
Eccentric blades, worn part built up.
Eccentrics, worn part built up.
Eccentric straps, broken and welded; worn part built up.
Engine-truck frames, broken and welded; cracked and welded.
Engine-truck boxes, broken and welded; cracked and welded.
Engine-truck cradle hangers, broken and welded; worn part built up.
Engine-truck radius bars, broken and worn; worn part built up.
Engine-truck pedestals, worn part built up.
Equalizer brackets, broken and worn.
Fire doors, broken and welded; cracked and welded.
Fire-door levers, broken and welded; cracked and welded.
Fire-door frames, broken and welded; cracked and welded.
Fire-door collars and patches, welded.
Fire-door ring castings, broken and welded; cracked and welded.
Fire-door latches, broken and welded; cracked and welded.
Flue-sheet patches, welded.
Frame braces, broken and welded; cracked and welded.
Frames, broken and welded; cracked and welded.
Front-end deck castings, broken and welded; cracked and welded; worn part built up.
Front-end pilot-beam braces, broken and welded; cracked and welded.
Front-end steam pipes, broken and welded; cracked and welded.
Front-end nozzle stands, broken and welded; cracked and welded.
Front-end nigger heads, broken and welded; cracked and welded.
Grate bearings, broken and welded; cracked and welded.
Grate-shaker bracket broken and welded; cracked and welded.
Guide blocks, worn part built up.
Guides, built up.
Guide yokes, broken and welded; cracked and welded.
Half-casing sheets, welded.
Handrail posts, broken and welded.
Injector valve seats, worn part built up.
Injector bodies, cracked and welded.
Injector delivery pipes, collars brazed.
Lubricators, cracked and welded.
Main and side rods, grease cups welded on rods.

Mud-ring corner patches, welded.
Mud rings, built up.
Pedestals, built up.
Pilot beams, broken and welded; cracked and welded.
Pilot braces, broken and welded.
Piston heads cracked and welded; built up with bronze bottom sector one-third for wear.
Piston fits, built up.
Piston-rod-extension guides, broken and welded; cracked and welded; worn part built up.
Rear deck castings, broken and welded; cracked and welded.
Reverse levers, broken and welded; cracked and welded.
Reverse-lever latches, broken and welded; cracked and welded.
Reverse-lever quadrants, broken and welded; cracked and welded.
Reverse-lever reach rods, broken and welded; cracked and welded.
Rocker arms, broken and welded; cracked and welded.
Running-board brackets, broken and welded; cracked and welded.
Running-board steps, broken and welded; cracked and welded.
Sand-box castings, broken and welded; cracked and welded.
Side-rod straps, built up.
Side sheets, welded.
Slide valves, broken and welded; cracked and welded; worn part built up.
Smokestack and saddles, broken and welded; cracked and welded.
Spring bands, welded when made new.
Spring hangers, worn part built up.
Spring bearings, worn part built up.
Spring saddles, worn part built up.
Standpipes, broken and welded; cracked and welded.
Stoker parts, broken and welded; cracked and welded.
Superheater flues, safe ends and pits, welded.
Superheater headers, broken and welded; cracked and welded.
Superheater units, welded.
Tail bars, built up.
Throat-knuckle patches, welded.
Throttle brackets, broken and welded; cracked and welded; worn part built up.
Throttle-lever latches, built up.
Throttle-lever quadrants, broken and welded; cracked and welded; worn part built up.
Throttle stems, broken and welded; cracked and welded; worn part built up.
Truck bolsters, broken and welded; cracked and welded.
Truck center castings, broken and welded; cracked and welded.
Truck oil boxes, broken and welded; cracked and welded.
Truck pedestals, worn part built up.

Boiler Welding

Welding boiler side sheets, flue sheets, tubes, and mud rings and boiler welding in general will not be discussed in this paper for several reasons: It is a big subject sufficient for one paper alone. Vital matters of safety are involved, too important for full discussion here. Rulings of the Interstate Commerce Commission in regard to boiler welding are conservative, as they should be in all matters of safety. Engineers and laymen have discussed the pros and cons of boiler welding, while railway officials, by reason of pressing needs, have gone ahead with welding and are doing it daily with few failures. Boiler welds have stood the trying conditions of railway service for years. The practice saves time and labor expense, and in general promotes durability because riveted seams and double sheet thicknesses are eliminated; overheating is avoided and circulation is less impeded.

Frames

Before the advent of modern welding processes the repair of a broken locomotive frame was a heavy and costly job. The frame had to be removed, which meant dropping the driving wheels and stripping of springs, brake rigging, and all parts depending on the frame for support. Frame bolts were removed with difficulty, often requiring drilling to loosen them when rusted. In consequence new bolts had to be forged and fitted.

The frame was heavy and cumbersome to handle in the blacksmith shop. Experience and skill were required to make a sound weld and at the same time avoid changing the length of the welded member. Often the weld necessarily distorted machined surfaces to such degree that planing was necessary. The ordinary labor required to move and replace a frame alone amounted to a considerable item.

When a broken frame is torch-welded it often can be done with the removal of no parts, or by dropping one pair of drivers and stripping the brake rigging from the frame next to the weld. Weld preparation may take two hours and the weld itself four to six hours, and cooling down, six to ten hours. Twenty-four hours may be sufficient time to start and clean up in. Compare this with the week or ten days, not uncommon under the older conditions of railway shop practice.

The welder can save or waste considerable time, gas, and welding rod when preparing a frame for welding. The conventional practice is to vee the frame as shown in plan in Fig. 1, making the angle of the vee about 90 degrees. The reason for cutting a vee when preparing for a weld is simply to give access with the torch to the parts to be united. All metal cut away must be restored, and that cut away unnecessarily represents waste of effort and materials. Hence an expert welder working for

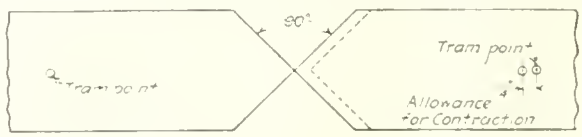


Fig. 1

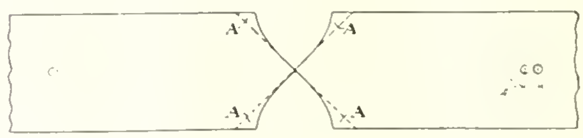


Fig. 2

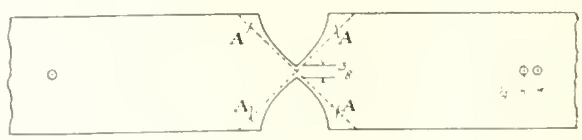


Fig. 3

Fig. 1. Conventional Frame—Weld Preparation.
Fig. 2. Frame—Weld Preparation That Reduces Time and Cost of Welding.
Fig. 3. Frame—Weld Preparation That Still Further Reduces Time and Cost of Welding.

the common interest of himself and his company will consider carefully the preparation of a heavy-section weld in a locomotive frame. Instead of cutting the vee with straight sides he will be well advised to cut them somewhat along the lines of Fig. 2. The metal represented in areas *A, A, A, A* will be saved and still plenty of space assured for manipulating the torch and making a sound weld.

A still further saving can be made by not cutting the ends to a sharp point, but leaving from ¼ inch to ⅜ inch at the center untouched. The layout will then be approximately as shown in Fig. 3. The areas *A, A, A, A* are thus enlarged. The ends must be jacked apart a distance of ¼ in. to 5/16 in. before starting to weld in order to provide contraction allowance and to preserve the original overall length.

On a frame section 4 in. thick and 5 in. deep, about 20 cu. in. of frame material can be saved as compared with that removed, if the vees are cut as shown in Fig. 1. This means a saving of 1 to 1½ hr., 6 to 7 lb. of welding rod, 120 cu. ft. of acetylene, and 130 cu. ft. of oxygen. The saving effected will be sufficient to take care of the reinforcement or building up of the weld above the original frame surfaces.

Frames chafed by spring hangers are repaired by building up the worn places to the original thickness. In some shops, pieces are laid in and welded at the ends. The objection to this practice is that, as ordinarily done, frame strength is not restored, whereas, if built up by sound welding the worn section is made practically strong as when new.

Cylinders, Piston Rods, Pistons

Repairs to cylinders include welding cracks in the barrel, replacing parts broken out in collisions or by breaking piston rods, broken cylinder heads, replacement of broken bridges in valve seats, etc., In some cases brazing is preferred to welding where a short crack has developed. The repair can be done at less cost and generally with entire satisfaction. Steam passages in the cylinder saddle can be repaired by brazing when the cracks are accessible. Such jobs will generally require the cylinder to be removed from the engine, whereas most repairs to the barrel and valve seats can be done without stripping the cylinder from the engine.

Piston rods that have worked loose in the piston are built up on the taper so that the taper part can be turned and fitted without losing the original overall length. Sufficient metal should be put on to allow for reaming the piston. In this way a piston rod can be saved at comparatively small cost.

It is not generally advisable to attempt the same treatment for a loose fit in the crosshead. The preferable method in this case will be to fill in the forward end of the key slot with a "dutchman" welded or brazed fast and then to fit the piston rod in the crosshead. If this refitting shortens the rod too much, the taper at the piston end should be built up and refitted, as before described, to compensate for the loss of working length.

Crosshead guides badly worn on the sides may be restored to standard width by welding thin steel strips to the sides and then planing the guide to width. The steel strips should be not less than ⅛ in. thick when finished by planing. If the amount worn away is insufficient to permit the use of strips of the required thickness, it will be necessary to plane the sides down before welding on the strips.

The strips should be toe-welded, that is, welded along the edges and ends only. Where broad surfaces are built up in this manner to compensate for wear it may be desirable to drill holes in the middle through which the plate can be welded to the part beneath. These welds prevent the plates from buckling and springing away.

Pistons worn away on the lower sector are restored to size by building up the worn surfaces with manganese bronze. The bronze is fused to the cast iron and is piled up to the required height to restore the piston to the original diameter. A core plug is removed before preheating the piston to prevent setting up a dangerous pressure in the cored interior should oil and water have worked their way inside.

In laying up the bronze on the piston, the operator should avoid filling in the piston-ring grooves. Of course, that is easily done; the bronze should be built overhanging the grooves so that when the piston is turned and the grooves machined in the lathe there will be enough manganese metal to clean up and make a workmanlike job

Wheel Centers

It is not generally considered advisable to attempt the repair of a cracked wheel-center hub. Conditions sometimes have been such during the past few years that it was not feasible to balance the cost of new parts against the cost of repaired parts. In other words, new parts were not available except on long-time deliveries, and it became imperatively necessary that the old part be restored to working condition; hence we have an example of welding a cracked hub. The cost was high, but high as it was, it was acceptable, because making such repairs meant putting a locomotive into service.

To weld a cracked hub is an undertaking worthy of the skill of the best welder. It can be done successfully at a cost comparing favorably with that of a new steel center, but perhaps greater than the cost of a cast-iron center. This will depend on local conditions, wages, cost of gases, and other items going into the cost of shop repairs.

A wheel center having a cracked hub is welded lying down. Of course the wheel must be pressed off the axle and the crankpin should be removed, as it is likely to be loosened by the heat. The crack is veed out on each side. Observe the same rule specified in the section on welding frames, and avoid as far as possible removing metal unnecessarily.

The wheel center should be blocked up on firebrick or iron supports and preheated with a charcoal fire for several hours before starting to weld. If the rim is solid it must be cut apart opposite the weld in order to provide for the expansion of the center. In fact, it may be necessary to make two opposite cuts through the rim to take care of this expansion. In passing, the author would say that it is not necessary, usually, to weld the cuts made in the rim. Filling pieces may be, and are, fitted in the gap to take the contraction pressure of the tire.

Welding the hub can be done so that the axle bore is reduced sufficiently with good management to permit fitting to the old axle, but the crankpin hole will be enlarged by removal of the pin, and it is generally advisable to rebore it to insure truth with the axle. This means, of course, that a new crankpin will be required.

Two welders should work together on heavy welding in order to insure continuous and rapid work, and the maintenance of favorable conditions throughout the job. This applies especially to frame welds.

Wheel-Center Spokes

Cracked and broken spokes of cast-iron and steel driving centers are welded successfully, if provision is made for expansion and subsequent contraction. This means that the tires must be removed from the wheel centers before undertaking to weld. Attempts to weld spokes with the tires in place are always unsatisfactory. The wheel-center rim will be pulled away from the tire, leaving a space between which, if not filled with a tightly fitted shim, will result in a broken or loosened tire.

The ends of the broken spoke are beveled or veed and the ends spread apart about ⅛ in. before starting to weld. The spread between the ends of course depends on the wheel diameter and the size of the spoke section.

Spreading the spokes apart is generally done by heating the rim and adjacent spokes with an oil burner or other convenient means for local heating. The spoke should be trammed before spreading the ends apart, and the original length carefully prickmarked, the same as in frame welding. In this case, as is the rule in all others, a tram should be used long enough to span the heated area—say, 18 in.

Care must be taken that the allowance for contraction between the spoke ends is maintained until the weld is finished. Generally, the welding is done without removing the wheel from the axle and with the wheel in a vertical position, as this makes it easy to roll the wheel from time to time to favor welding.

An expert welder of experience can handle spoke welding so well that when finished and cold the contour of the rim will be practically perfect. The aim in all cases should be to raise the rim to the original position, or slightly higher. If the rim is slightly raised when the spoke is finished, the shrinkage of the tire on the wheel center will compress the weld metal in the welded spoke, making the shape practically true. It is hardly possible in spoke welding to raise the rim so much that truing up in a wheel lathe will be necessary, and it would not be advisable to do it if it were possible, because of the increased cost and liability of being obliged to reduce the diameter below the standard size.

Pipes, Tires, Etc.

Steam and Exhaust Pipes. Broken ears on cast-iron steam and exhaust pipes are restored by welding. Usually no attempt is made to preserve the bolt holes. The ears are built up and the holes drilled.

Surfaces of steam and exhaust pipes that have been wasted away by corrosion are readily built up to their original thickness. In all cast-iron work of this nature the casting must be preheated to a dull red to prevent undue expansion and contraction stresses. Although kerosene burners are much used for preheating, charcoal is also much used where available, and is preferred by many welders, because of the soft diffused heat and more agreeable characteristics.

Firebrick, sheet iron, and sheet asbestos are employed in building preheating furnaces, suitable for any size or shape. Charcoal quickly takes fire and produces the degree of heat suitable for preheating work without danger of overheating any spot excessively. Sheet asbestos is used liberally on heavy welded parts while cooling down; also to prevent radiation losses on frames, etc.

Pilot Beams

A hollow steel-casting pilot beam crushed or badly dented by a collision is readily repaired by cutting out the bent section with the cutting torch and welding in a steel plate of the same thickness as the casting wall. The appearance and strength are made as good as new. This repair can generally be made without reheating or removing the beam from the engine.

Sharp Tires

When tire flanges become worn sharp, a dangerous condition exists which must be corrected. Common railway-shop practice is to drop the driving wheel and turn the tires to the correct contour. This means taking the locomotive out of service for several days, and the loss of tire steel that must be removed from the entire set in order that the tires shall be of common diameter and correct flange shape. Often one tire only has developed a sharp flange, and it is apparent that turning the tires is a wasteful and costly practice in the light of present possibilities.

Oxy-acetylene welding is being successfully applied to the correction of this defect produced by uneven wear. If the flange is less than 1½ in. above the tread, the sharp corner is filled in at the base of the flange with weld metal, preserving as nearly as possible the contour.

The operation of building up a sharp tire is commonly done at the rate of one tire per man per day, but the time required depends of course on the diameter, extent of wear, and skill of the operator; also on the manner in which the work is handled. If the welder must move the locomotive with a pinchbar to follow around the tire, he loses considerable time, but if the parallel and main rods are taken down and means are provided for turning the wheel by power (referring to the wheel-turning device used for valve setting), welding time will be considerably reduced. The cost of restoring a sharp flange, even under the most disadvantageous conditions, is a fraction of the cost of dropping the wheels and turning the set in the wheel lathe.

Brake-Lever Bearing Shafts

A plain shaft 4 in. in diameter and 30 in. long used as the fulcrum shaft for the brake-cylinder levers on a certain type of locomotive is not a profitable reclamation job when badly worn. The cost of building up the worn surfaces and turning to size is more than the cost of the steel and machine work required for a new shaft. It is only when steel of the required diameter and length is not available and the time required to requisition it from the head storekeeper would delay completion of repairs, that reclamation by building up with the torch would be warranted. This is mentioned as an example of practice to be avoided by those whose zeal for welding sometimes leads to excess.

Injectors and Air Pumps

Injector valve seats worn away by repeating facing with a valve-seat reamer are replaced by boring out the seat and cutting a thread for a seat ring. In time the thread fit between the ring and injector body becomes defective and steam leaking past cuts away the body metal to such an extent that further repairs by old-time methods are no longer feasible. Such jobs are easily made good with the torch, a new wall across the opening being built up with bronze. A small carbon block is set beneath to support the hot fluid metal. This block is removed when the valve seat is bored and faced.

The lift of check valves in air pumps becomes excessive when the abutments are worn away by the continuous hammering. These abutments are readily built up with cast iron or bronze to a height that permits them to be faced off to the original standard height, thus making valves of non-standard dimensions to limit the lift unnecessary. This is only one of many minor jobs on air-pump parts that help to keep the motive power in good condition. The master mechanic or other official in charge should study possibilities of cost saving and choose with discretion those that are profitable and reject those that are not.

Steel Tender Transoms

Some tender transoms on certain locomotives proved to be weak in the center beneath the pivot plate. The steel casting broke down, shearing off the ribs, *A*, Fig. 4, that tied the center bearing plate to the kingbolt center.

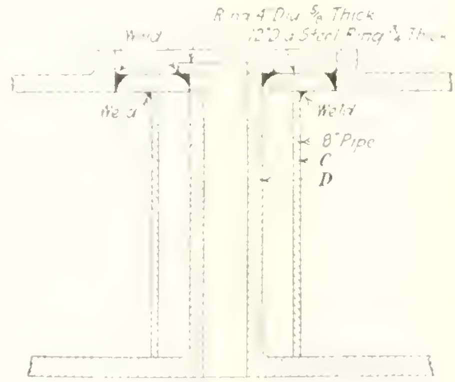


Fig. 4—Details of Welds Used in Repairing Tender Transom Shown in Fig. 5

The break was hard to reach with a welding torch. The steel casing was therefore cut away with a cutting torch so that a 12-in. steel-plate disk, *B*, Fig. 5, ¾ in. thick could be set in to make a new bearing. A hole was cut in the center to fit over the kingbolt center, *D*, and a piece of 8-in. pipe was cut to fit the distance from the under side of the pivot plate to the bottom member of the transom. The plate *B* and the pipe were welded together, and the assembly set in position. The bearing plate was welded at the edge and center as shown in Fig. 5. To form the inner guide for the pivot casting above a ring about 4 in. in diameter and $\frac{5}{8}$ in. thick was cut and welded to the top.

The cost of a new transom was about $40 and the salvage cost about $22. The salvaged transom is about 100 per cent stronger than in the original form.

Supervision

Welding in the railway repair shop, the same as in other special activities, must be supervised by a competent foreman or head welder. In all too many places the welders lead a somewhat happy-go-lucky existence, deciding themselves to a large degree what can be and what cannot be done with the torch. The result is that sometimes hot, disagreeable jobs are "passed up" as being impracticable,

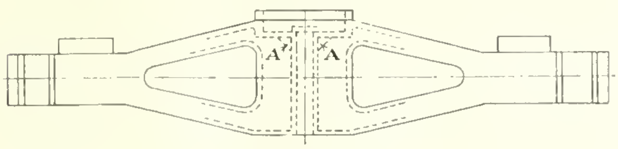


Fig. 5—Steel Tender Transom Member Showing Defective Center Support

and parts are scrapped that could be profitably repaired. Apparatus sometimes is not kept in first-class working order. Pressure gauges are allowed to go in disrepair, hose is used in bad condition, and welding tips are thrown away when a slight defect develops that may be easily corrected.

Such conditions are due largely to the fact that many shop foremen, having had no personal experience in welding, have vague ideas of sound practice. They necessarily depend on their welders to devise ways and means for doing their work, and if the verdict in a particular case is for or against, they feel that they must necessarily accept it. This condition is rapidly improving, due, of course, to the awakened interest in welding and also to the valuable service rendered by industrial engineers employed by the large concerns promoting the sale and use of welding equipment and supplies.

Service of Manufacturers of Gases and Apparatus

The business of a locomotive repair shop is to keep the motive power in operating condition. The energies of those responsible are absorbed in taking care of routine duties and meeting emergencies constantly arising. In general, the officials and their subordinates have little time to spend in analyzing and improving machines or processes, and this is particularly true of the modern welding methods and gas cutting. Service offered and rendered by the large manufacturers of gases and apparatus is a real service that relieves the officials of many worries and helps them to raise the efficiency of their welding and cutting practice.

Railway service comprehends recommendation of torches, tips, gas pressures, methods of welding and welding preparation, analysis of jobs that can be done profitably by welding, training of welders, distribution of gases by pipe lines, installation of pipe lines and safety devices, oxygen manifolds, acetylene generators where desirable, location of welding stations, care of gas cylinders, care of apparatus, repairs to torches, regulators, tips hose, etc.

Railway mechanical officials have the reputation of being generous in the exchange of ideas and methods. There are few who do not gladly pass on that which they have learned by experience to be good.

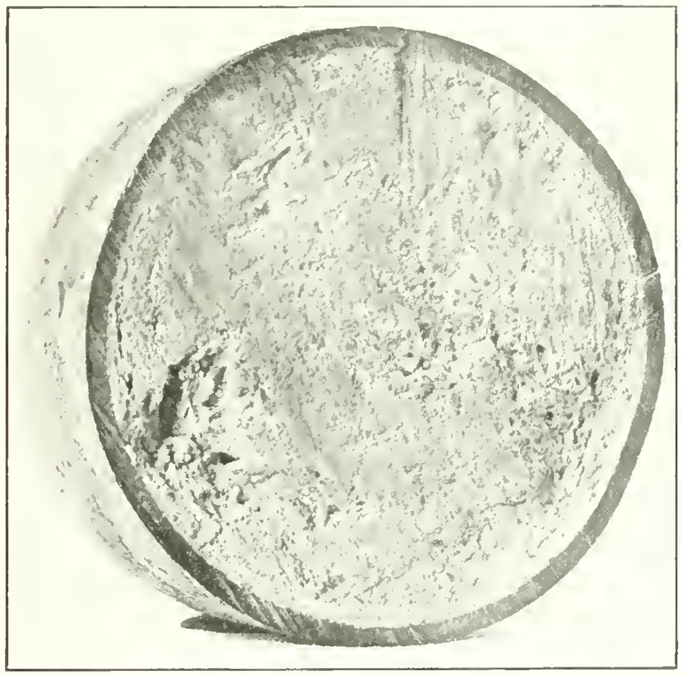
A Neglected Delivery Pipe

Some time ago one of the government inspectors, while investigating a locomotive crown sheet failure, found that the delivery pipe from the injector was completely filled with scale. The pipe was cut off and a piece removed and photographed, a reproduction of which is shown in the accompanying engraving.

The boiler involved was equipped with one twin check located in the back head, from which an internal delivery pipe ran, in the usual manner, forward to the discharge end in the shell.

When the check and the internal delivery pipe were removed the interior of the pipe was found stopped up solid with hard scale.

There was a check valve in this internal delivery pipe, but it was broken. Near the check there was a slotted opening in the delivery pipe $\frac{3}{8}$ in. wide and 8 in. long and midway of this slot the pipe was torn for about 2 in. cre-



Delivery Pipe from Injector Completely Filled with Scale

ating an opening about $\frac{1}{2}$ in. wide through which the water from the injectors passed into the boiler.

Such a case as this emphasizes the necessity for eternal vigilance in the guarding of delivery pipes especially in bad water districts. Every once in a while a report is received of a boiler failure caused by an insufficient supply of water because of an obstructed delivery pipe. It is rarely, however, that such an example as this is found where the pipe is entirely filled.

The probability is that as the pipe filled the resistance to the flow of water gradually increased until the pipe burst, affording some relief, after which the water, moving slowly through the small aperture remaining, made a rapid deposit of scale until the pipe was filled.

55% of Locomotives Examined Defective

According to the report of the Interstate Commerce Commission on the condition of railroad equipment, during the month of October 6,507 locomotives were inspected by the Bureau of Locomotive Inspection and 55 per cent were found defective, while 525 were ordered out of service; also 103,827 freight cars were inspected, of which 4.7 per cent were found defective, and 2,300 passenger cars, of which $1\frac{1}{2}$ per cent were found defective.

How Railroads Must Spend Money to Save Money

The Illinois Central System has just issued a statement showing how the railroads must spend money in order to save money.

The statement shows that the Illinois Central's freight business, as measured by the number of tons carried one mile, was 97 per cent greater in 1922 than in 1910. This 97 per cent increase in ton miles was performed with an increase of only 5 per cent in the number of freight train miles. In other words, longer and heavier trains were run.

If the average freight train load, according to the company's figures, had been in 1922 what it was in 1910, an increase of 94 per cent in freight train miles, instead of only 5 per cent, would have been required to handle the 1922 freight traffic. This would have meant that the direct costs of freight train operation, which includes wages, fuel, lubricants and other supplies, would have been $21,341,652 greater in 1922 than they actually were.

The way in which this saving was accomplished was by reduction of grades so that a greater tonnage could be handled in a train; old locomotives were replaced by more powerful ones; terminal facilities were enlarged; second main track, and in some instances third main track, were added, and new yards constructed and new signals installed.

Since 1910 the Illinois Central has expended $225,000,000 in this kind of work, almost all of which sum has been obtained from the investing public.

"Railway earnings," the statement says, "must be kept at a rate sufficient to encourage investment in railway securities on a large scale."

Fuel Economy on the New York Central

During August this year a record was established by the New York Central R. R. in the unit fuel consumption in passenger service of 11.9 lbs. per passenger car mile, which is the lowest unit consumption produced in any one single month since fuel records were originated in 1919. Combining the fuel used in passenger, freight and switch services, using the unit performance in each service based upon the volume of business and cost of coal during August, 1923, the month of August shows a saving of $275,000, compared with August, 1922; $35,000, compared with August, 1921; $200,000, compared with August, 1920, and $129,000, compared with August, 1919.

Annual Meeting of the Railway Business Association

The annual meeting and dinner of the Railway Business Association was held at the Hotel Commodore, November 8. About 12,000 members and guests were in attendance. Alba B. Johnston, president of the association, presided. The principal speakers at the dinner were Julius Kruttschnitt, chairman of the executive committee of the Southern Pacific, and James R. Howard, president of the National Transportation Institute.

Mr. Kruttschnitt discussed the question of further trial of the present law versus amendments of the Transportation Act. In the course of his remarks he said:

"Neither the railroads nor the people of this country can know the full possibility of transportation service under the provisions of this act until it has been in operation for a reasonable length of time under more stable and particularly under normal conditions, which we have pointed out have not prevailed during 1920 and 1922, the first three years after return to private control."

In his address, Mr. Howard dwelt upon the necessity of the farmer and transportation interests meeting on common ground and with that end in view, outlined in detail the purposes of the National Transportation Institute which he explained, "is to promote understanding through the ascertaining of essential facts of transportation—to study the correlation of the different kinds of transport, the relationship of transportation to industry as a whole, and the translating of these facts from the usual economic or technical verbiage to the understanding of the men on the field or on the street."

Railroads Pay Higher Wages Than Government

The average wages of railway employes are higher than the average of those paid to Government employes. A study of the number and wages of all Givernment employes in the United States—local, state and federal—recently made and published by the National Industrial Conference Board, shows that the average wage of Government employes at the present time is $1,296 a year, while the average wage of railroad employes is $1,643 a year, or about 27 per cent more than that of Government employes.

Records show that railroad employes have been paid higher wages in every year since the railways were returned to private operation than they were under Government operation.

In 1918 the average railroad wage was $1,419, and in 1919, $1,485. These were the two years throughout which the railroads were operated by the Government. In 1920 the average wage of railroad employes was $1,820; in 1921, $1,665, and in 1922, $1,630. In 1923 it was about $1,643.

Half of Nation's Freight Cars Are Moved in One Day

The railroads on October 17 moved more freight cars—that is both loaded and empty cars—than ever before on any one day in history, according to reports just filed by the carriers with the Car Service Division of the American Railway Association.

Fifty-two Class 1 railroads, representing about 90 per cent. of the mileage for that class of carriers, on that day moved 1,029,428 cars.

The significance of this performance can be realized more readily when consideration is given to the fact that this represents approximately one-half of the total number of freight cars owned by the railroads of the United States. The best previous record was made on September 26, this year, when 1,013,724 cars were handled.

In 1920, when, except for this year, more traffic was carried by the railroads than ever before, even including the war years, the peak movement of both loaded and empty cars was 947,098, which was reached on October 28, that year. But even that record, which stood until this year, has been exceeded four times since August 29, 1923.

News Bulletin of National Transportation Institute

The National Transportation Institute, Chicago, Ill., is now issuing under the title of "Transportation," a weekly bulletin to record the news for those interested in its activities.

The bulletin will publish news and announcements regarding the Research Council and the activities at the headquarters of the Institute and will present facts and principles about transportation as found by the Research Council, especially in their relation to industry, agriculture, commerce and finance. The paper will be used exclusively for the news of the Institute.

Railway Mechanical Conventions at Atlantic City

The railway mechanical conventions will be resumed next year at Atlantic City, N. J., with exhibits by the supply manufacturers according to the announcement of the associations concerned. Division V, Mechanical, of the American Railway Association will hold its annual meeting at Atlantic City, June 11 to 18 inclusive, 1924. Announcement will be made later in the pages of this paper as to the details and the order of the sessions.

155,872 New Cars Installed Since First of Year

More new freight cars and locomotives have been placed in service since January 1 this year than in any similar period since 1913. This is shown in current reports filed with the American Railway Association.

From January 1 to November 1, a total of 155,872 new freight cars were installed in service, of which 21,236 were delivered by the builders and placed in operation during the month of October.

There have also been placed in service during the first ten months this year 3,371 new locomotives, of which number 408 were installed during October.

Of the new freight cars placed in service during October, box cars numbered 7,583; coal cars, 10,592; refrigerator cars, 1,753, and stock cars, 665.

The railroads on November 1 had 48,571 new freight cars on order, with deliveries being made daily. Of that number, box cars totaled 22,691; coal cars, 18,245; refrigerator cars, 3,496, and stock cars, 2,791.

The railroads on November 1 also had 942 new locomotives on order.

Notes on Domestic Railroads

Locomotives

The Alabama & Vicksburg Railway has placed an order for 3 Pacific type locomotives with the Baldwin Locomotive Works.

The Canadian Pacific Railway is reported to be contemplating the purchase of a number of locomotives.

The Argentine State Railways have purchased one locomotive from the Baldwin Locomotive Works.

The Winchester & Western R. R. has purchased one Shay locomotive from the Lima Locomotive Works.

The Southern Pacific Co. is reported to have purchased twenty switchers of the 0-6-0 type from the Lima Locomotive Works.

The St. Louis & O'Fallon Railway has entered the market for one locomotive.

The Union Pacific R. R. is reported to be in the market for 60 locomotives.

The Rutland R. R. is reported to be in the market for 4 locomotives.

The Temiskaming & Northern Ontario Railway has ordered 3 Mikado type locomotives from the Canadian Locomotive Company, Ltd.

The Minnesota Steel Co. has purchased one locomotive from the Baldwin Locomotive Works.

The Southern Pacific Co. has placed an order for 18 Mountain type locomotives with the American Locomotive Company.

The Delaware Lackawanna & Western R. R. has placed an order for 25 locomotives with the American Locomotive Company as follows: 10 Mikado type, 10 Pacific type and 5 Mountain type. The Mikado type will have 28 by 32 in. cylinders and a total weight of 357,000 lbs. The Pacific type will have 25 by 28 in. cylinders and a total weight of 297,000 lbs. The Mountain type will have 28 by 30 in. cylinders and a total weight of 370,000 lbs.

The Toledo, Angola and Western R. R. is in the market for one locomotive.

The Long Bell Lumber Company has ordered 3, 70 ton geared locomotives from the Willamette Iron & Steel Works, Portland, Ore.

Freight Cars

The Ulster & Delaware R. R., has ordered 10 caboose cars from the Pressed Steel Car Company.

The Alabama & Vicksburg Ry. has entered the market for 200 box cars, 100 gondolas and 100 flat cars.

The Spokane, Portland & Seattle Ry., has ordered 50 cars from the American Car & Foundry Company.

The Chesapeake & Ohio Ry. is in the market for 2,000 gondola cars.

The Chicago & Alton R. R. is inquiring for 250 box cars of 40 tons capacity.

The Cambria & Indiana R. R. has placed 250 hopper cars for repairs with the American Car & Foundry Company.

The Nashville, Chattanooga & St. Louis Ry. is inquiring for 100 or more combined ballast and coal cars.

The Union Pacific R. R. is reported to be in the market for 3,000 refrigerator cars.

The Ann Arbor R. R. is inquiring for 500, 40 ton box cars.

The Yosemite Valley R. R. is in the market for 50 hopper cars.

The Philadelphia & Reading Ry. is inquiring for 20 caboose cars and 50 stock cars.

The Chicago, Burlington & Quincy R. R. is in the market for repairs to 1,000 gondola cars.

The Great Northern Ry. is in the market for 500 stock cars with steel construction.

The National Railways of Mexico are in the market for about 400 box cars.

The Lehigh Valley R. R. is inquiring for 25 milk cars.

The Fruit Growers' Express is inquiring for 600 steel underframes for refrigerator cars to be built in its own shops at Indiana Harbor.

The Illinois Traction, Inc., is inquiring for 100 box cars of 40 tons capacity.

The New York, Chicago & St. Louis Ry. is in the market for repairs to 200 box cars and 200 gondola cars.

The Belt Railway of Chicago is inquiring for 47 center sills.

The Southwestern Railway is inquiring for 1,000 steel center constructions.

The Cairo, Truman & Southwestern R. R. is inquiring for 30 logging cars of 40 tons capacity.

The Wabash Ry. is inquiring for 1,750 automobile cars, also 250 gondola cars.

The Northern Pacific Ry. is reported to be in the market for 1,000 underframes for ore cars.

The Carnegie Steel Company will have repairs made to 498 steel hopper cars, 248 at the shops of the Koppel Car Repair Company, 200 at Greenville Steel Car Company, and 50 at Federal Shipbuilding Company.

The New York, Chicago & St. Louis R. R. will build 15 caboose cars in its own shops.

The Baltimore & Ohio R. R. has ordered 500 hopper car bodies from the Pressed Steel Car Company, and 500 box car bodies from the American Car & Foundry Company.

The Lehigh & New England R. R. has ordered 7 caboose cars from the Magor Car Corporation.

The Southern Pacific is inquiring for 2,975 box cars of 50 tons capacity, 950 flat cars, 205 tank cars of 12,500 gal. capacity, 75 caboose cars, 500 automobile box cars, 250 stock cars, 600 drop bottom gondola cars, 500 flat bottom gondola cars, 500 logging cars and 4,325 50 ton cars.

The Western Pacific is inquiring for 200 automobile cars.

The Anaconda Copper Mining Company has ordered 24 dump cars from the Koppel Industrial Car & Equipment Co.

The Pacific Fruit Express contemplates buying about 3,000 refrigerator cars.

The Rio Grande do Sul Brazil is inquiring through the car builders for 200 28 ton steel frame flat cars.

The St. Louis Southwestern is inquiring for 150 steel underframes, also for 1,000 double sheeted steel underframes box cars of 40 tons capacity.

The Southern Ry. is inquiring for 1,000 box cars of 40 tons capacity and also 1,000 steel underframes.

The Northwestern Railway of Brazil is inquiring through the car builders for 200 box cars, 100 cattle cars, 60 gondola cars and 40 flat cars.

The Lehigh & Hudson River Ry. is inquiring for 10 milk cars.

The Lehigh Valley R. R. is inquiring for 25 milk cars.

Passenger Cars

The Chicago & Alton R. R. contemplates coming in the market for a number of cars, including coaches, dining cars, postal cars and baggage cars.

The Louisville, Henderson & St. Louis Ry. has ordered 4 coaches and 3 baggage and mail cars from the American Car & Foundry Company.

The Canadian National Railways has ordered 6 55-ft. steel combination passenger, smoking and baggage storage battery cars to be equipped with Edison batteries, General Electric motors, and controls, and Westinghouse Air Brake from the Railway Storage Battery Car Company, New York, through the Internation Equipment Company, Ltd., Montreal, Canada.

The Central R. R. of New Jersey has ordered 50 steel coaches from the Standard Steel Car Company, 5 combination passenger and baggage cars from the Pressed Steel Car Company, and the 10 baggage cars from the American Car & Foundry Company.

The Toronto, Hamilton & Buffalo Railway has ordered 16 coaches and 6 smoking cars from the Canadian Car & Foundry Co.

The Gulf Coast Lines has ordered 6 coaches and 4 baggage cars from the American Car & Foundry Co.

The New York Central R. R. has ordered for the Pittsburgh & Lake Erie 18, 70 ft. steel passenger coaches from the Standard Steel Car Company and has also ordered 18, 70 ft. steel passenger coaches from the American Car & Foundry Co.

The Alabama & Vicksburg Railway is inquiring for 4 coaches, 3 combination cars and 1 baggage car.

The Havana Central has ordered 6 high speed interurban motor coaches from the Wason Manufacturing Company.

The Baltimore & Ohio R. R. is inquiring for 50 passenger cars and 4 diners.

The Tennessee, Kentucky & Northern R. R. has ordered one completely equipped motor car from the Edwards Railway Motor Car Company, Sanford, No. Car.

The Chesapeake & Ohio Ry. has ordered 6 mail cars from the Pullman Company.

The Canadian Pacific Ry. has ordered 15 steel frames from the National Steel Car Corporation.

The New York, Westchester & Boston Ry. is inquiring for 10 passenger cars.

The Seaboard Air Line Ry. is inquiring for 3 combination baggage and mail cars and for three horse cars.

Buildings and Structures

The Erie R. R. has awarded a contract to Roberts & Schaefer Company, Chicago, Ill., for the construction of a 200 ton steel automatic electric coaling station at Brier Hill, Ohio.

The Wabash Railway has prepared plans for an addition to its engine house and shop at Moberly, Mo., to cost approximately $65,000.

The Atchison, Topeka & Santa Fe Railway has awarded a contract to Joseph E. Nelson & Sons, Chicago, Ill., for the construction of an apprentice school building at San Bernardino, Calif., to cost approximately $30,000.

The Southern Pacific Co. contemplates constructing a new shop building and roundhouse facilities at Valentine, Texas.

The Baltimore & Ohio R. R. has awarded a contract to Joseph E. Nelson & Sons, Chicago, Ill., for the construction of water treating plants of 100,000 gallons per hour capacity each at Old River Junction, Ohio, Troy, Lima, Deshler and Rossford.

The St. Paul Union Depot plans the construction of a roundhouse adjoining the Union Depot yards at St. Paul, Minn., to cost approximately $75,000.

The Galveston, Harrisburg & San Antonio-Southern Pacific Ry. will construct an addition to its engine terminal at San Antonio, Texas, at a cost of $80,000 including boiler washing plant and enlargement of roundhouse by the construction of three additional engine stalls and the extension of the existing six stalls.

The Delaware, Lackawanna & Western R. R. is planning the construction of a new engine house and repair shop at Binghamton, New York.

The Pennsylvania R. R. has prepared tentative plans for new locomotive and car shops near Dennison, Ohio.

The New York, New Haven & Hartford R. R. has completed plans for the construction of a one-story building and repair shop at Boston, Mass.

The Canadian National Railways contemplate the erection of an addition to the St. Malo shops at Quebec, Canada.

The Chicago, Milwaukee & St. Paul Railway will soon commence the construction of a new engine house with repair department at Monticello, Iowa.

The Chicago, Rock Island & Pacific Ry. has awarded a contract to Joseph E. Nelson & Sons of Chicago, Ill., for the construction of new engine house with repair department at Shawnee, Okla.

The New York Central R. R. is taking bids on a general contract for the construction of a new one-story shop at Harmon, New York.

The Pittsburgh & West Virginia Railway is taking bids on the construction of a one or two story power house and boiler shop near Pittsburgh, Pa.

The Philadelphia & Reading Railway has awarded a contract to the Roberts Filter Manufacturing Co., of Darby, Pa., for the furnishing and installation of filtration equipment at the Bulson Street engine house at Camden, N. J.

The Illinois Central R. R. has awarded a contract to the Drumm Construction Company, Chicago, Ill., for the construction of additions to its shops and yards at Evansville, Ind., to cost $1,000,000.

The Wabash Ry. has prepared plans for an addition to its company hospital at Decatur, Ill., and will begin work in the Spring. The addition will be 37 by 140 ft. and two stories high.

The Missouri Kansas Texas R. R. has awarded a contract to H. B. McCoy, Cleburne, Texas, for the construction of additions to its car shops at Denison, Texas, to cost $200,000.

The Fort Dodge, Des Moines & Southern R. R. has awarded a contract to the W. J. Zitterell Construction Co., Des Moines, Iowa, for the construction of a brick and concrete car house and yard office at Fort Dodge, Iowa, to cost $150,000.

Items of Personal Interest

C. J. Bauman has been appointed supervisor of boiler inspection and maintenance of the New York, New Haven & Hartford R. R. with headquarters at New Haven, Conn.

J. E. Brown, mechanical engineer of the St. Louis Southwestern Railway has been promoted to assistant superintendent of motive power with headquarters at Pine Bluff, Ark.

H. C. Manchester, superintendent of motive power and equipment of the Delaware, Lackawanna & Western R. R. with headquarters at Scranton, Pa., has resigned and **C. J. Scudder**, superintendent of shops at Scranton, has been appointed acting superintendent of motive power.

W. C. Stone, master car builder of the St. Louis Southwestern Ry. has resigned to become mechanical superintendent of the American Refrigerator Transit Company with headquarters at St. Louis, Mo.

John H. Daley, master mechanic of the New York, New Haven & Hartford R. R. has been appointed mechanical superintendent, Lines West, succeeding **A. A. Harris**, assigned to other duties. **J. P. Egan** has succeeded **Mr. Daley** on the Boston division. **D. P. Carey** has been appointed master mechanic of the Midland division. **J. B. Wyler** has been appointed master mechanic of the Hartford division. **L. G. Marette** has been appointed master mechanic of the Old Colony division, and **O. H. Ritter** has been appointed master mechanic of the New Haven division.

W. F. Crowder has been appointed general car inspector of the Pere Marquette Ry. with headquarters at Grand Rapids, Mich. He succeeded **J. McKenzie**, deceased.

M. King, has been appointed road foreman of engines of the Southern Pacific with headquarters at San Francisco, Calif., succeeding **H. L. Moore**, who has been assigned to other duties.

F. P. Howell, shop superintendent of the Atlantic Coast Line R. R. with headquarters at Waycross, Ga., has been appointed superintendent of motive power with the same headquarters, succeeding **J. E. Brogdon**, deceased. **C. A. White**, master mechanic with headquarters at Waycross, has been appointed shop superintendent with the same headquarters, succeeding **Mr. Howell.**

E. D. Colon has been appointed shop efficiency engineer of the Pere Marquette Railway with headquarters at Detroit, Mich.

J. H. Painter, shop superintendent of the Atlantic Coast Line R. R., with headquarters at Rocky Mount, No. Car., has been appointed master mechanic with the same headquarters.

E. G. Sanders has been appointed fuel supervisor of the Panhandle & Santa Fe Ry., with headquarters at Amarillo, Texas.

Ewald H. Paepke has been appointed general boiler inspector of the Union Pacific R. R. with headquarters at Los Angeles, Calif.

M. W. Roloson has been appointed roundhouse foreman of the Rock Island Ry. with headquarters at Horton, Kan.

C. A. Law has been appointed foreman of the boiler shops of the Union Pacific R. R. with headquarters at Provo, Utah. Vice E. H. Paepke.

H. Honaker has been appointed roundhouse foreman of the Union Pacific R. R. with headquarters at Los Angeles, Calif., vice **John Balderston** assigned to other duties.

Philip J. Norton has been appointed district foreman of the Union Pacific R. R. shops at Council Bluffs, Ia.

George Whitmore has been appointed roundhouse foreman of the Norfolk Western Ry. with headquarters at Williamson, W. Va. **G. E. Whitmore, Sr.**, is made machine shop foreman at the same point.

Paul Buckman has been appointed night roundhouse foreman on the Santa Fe with headquarters at Argentine, Kan. **H. W. Woodward** has been appointed assistant foreman in the machine shops.

J. J. Hebert has been appointed general foreman of the Illinois Central R. R. with headquarters at Natchez, Miss., vice **J. N. Fox** appointed general foreman with headquarters at Cleveland, Miss., vice **F. L. Clark** resigned.

Harry D. Broadway, formerly roundhouse foreman on the Southern at Charleston, S. C., has been promoted to general foreman of the mechanical department at Greenville, S. C.

A. Brown, formerly master mechanic of the Canadian Pacific at Nelson, B. C., has been appointed division master mechanic at Calgary, Alberta.

E. J. Lemieux, heretofore trainmaster and division master mechanic of the Canadian Pacific, Alberta District, Calgary, has been appointed division master mechanic, Regina division, Saskatchewan District, vice **J. W. Keppel**, appointed Division master mechanic, Edmonton Division, Alberta District, Edmonton, Office, Regina, Sask.

R. A. Robinett has been appointed erecting shop foreman of the Norfolk & Western at Portsmouth, Ohio.

J. E. Body, machinist inspector on the Southern has been promoted and is now night roundhouse foreman at Appalachia, Va., succeeding P. A. Layman, resigned.

Supply Trade Notes

The Bradford Corporation has acquired all the capital stock and assets, and will assume all the obligations of the **Bradford Draft Gear Company**, the **Republic Railway Equipment Co., Inc.**, and the **Joliet Railway Supply Company.** These companies will be operated as one unit after December 31st, 1923. The office of the Bradford Corporation will be as follows: **Horace Parker**, President, New York; **Burton Mudge**, Executive Vice-President, Chicago, Ill.; **W. W. Rosser**, vice-president, Chicago, Ill.; **Floyd K. Mays**, vice-president, New York; **A. F. Stuebing**, chief engineer, New York; **E. H. Barnes**, secretary, New York; **James H. Slawson**, general manager, Chicago, Ill.; **William F. Hoffman**, treasurer, New York; **Charles A. Carscadin**, general sales manager, Chicago, Ill.; **Arthur L. Pearson**, assistant vice-president, Chicago, Ill. The executive committee will be **Fred A. Poor**, Chairman, **Horace Parker** and **Burton Mudge.**

The Bradford Corporation will maintain executive office at 25 West Forty-Third Street, New York, N. Y., and Railway Exchange Building, Chicago, Ill., and sales offices in Washington, D. C., St. Louis, Mo., San Francisco, Calif., Mexico City, Mexico. The Company will be represented in Canada by the **Holden Company, Ltd.**, Montreal, Que., Canada.

The Company will sell and manufacture Bradford Draft Gears, Bradford Draft Arms, Chambers Throttle Valves, Huntoon Truck Bolsters and Huntoon and Joliet Brake Beams.

Dwight E. Robinson has been appointed manager of Railway sales department for **Toch Brother, Inc.**, 110 East Forty-second Street, New York City.

Frank C. Pickard, master mechanic of the Delaware, Lackawanna & Western at Buffalo, has resigned to take a position with the **Talmage Manufacturing Company**, at Cleveland, Ohio.

The Crane Company, Chicago, Ill., will construct a two-story foundry 160 by 500 ft. at 4100 South Kedzie Ave., Chicago, Ill.

The Bethlehem Steel Company rail mill at Sparrows Point has resumed rolling rails after having been shut down since April, 1919.

G. N. Winner has been appointed general manager of the **Garlock Packing Company**, Palmyra, N. Y. Mr. Winner was formerly manager of the Philadelphia branch of the Garlock Packing Company and later served as president and also manager of the **Crandall Packing Company.**

H. E. Graham, manager of traffic and sales of the **Pressed Steel Car Company** and its subsidiary, the **Western Steel Car & Foundry Company** with headquarters at New York, has resigned to become vice-president in charge of sales of the **Illinois Car & Manufacturing Company**, with headquarters at Chicago, effective January 1st, 1924. **F. M. Garland**, assistant to Mr. Graham, will succeed him.

The American Car & Foundry Company has ordered the structural steel for a foundry at Madison, Ill., from the Kenwood Bridge Company.

at 527 Commercial Trust Building, Philadelphia, Pa., has had his territory extended so that it now comprises the state of Pennsylvania with the exception of the northeastern portion, the states of Maryland and Delaware, and the southern part of New Jersey.

The Jones & Laughlin Steel Company, office at Cleveland, Ohio, has been moved from 1314 Rockfeller Building, to 1407 Union Trust Building, Cleveland, Ohio.

The American Brake Shoe & Foundry Company has ordered the structural steel for a foundry building at Kansas City, Mo., from the Kansas City Structural Steel Company.

The Western Electric Company has plans for a power plant to be put up at Kearny, New Jersey, at a cost of $1,500,000 which were filed recently with the municipal superintendent of Kearny, N. J. This is the first unit of a construction programme to cost about $20,000,000. The Company has secured 60 acres in Kearny fronting on the Passaic River at the head of Newark Bay, as the site for its works, and also leased a three-story building containing about 110,000 sq. ft. floor space in Newark to be known as the Waverly Shops, also another piece of property has been secured in Jersey City containing about 240,000 sq. ft.

Obituary

Willard A. Smith, editor and publisher of the Railway Review, Chicago, died at Evanston, Ill., on November 29, at the age of 74. Mr. Smith was born at Kenosha, Wis., on September 20, 1849, and was educated at Shurtleff College, Upper Alton, Ill., from which he graduated in 1869. He then took up the study of law at Washington University, St. Louis, Mo., from which he graduated in 1871. In 1874 he became the editor and publisher of the Railway Review, so that at the time of his death he had nearly completed a half century as editor and publisher of the publication.

Mr. Smith was chief of the department of transportation of the World's Columbian Exposition, Chicago, in 1893, in which capacity he supervised the preparation of the transportation exhibit which attracted wide attention. Later he was director of transportation and civil engineering of the general commission of the United States to the Universal Exposition at Paris in 1900. In 1904, he served as chief of the department of transportation of the Louisiana Purchase Exposition at St. Louis. He was an American delegate to the International Railway Congress in Paris in 1900 and in Washington, D. C., in 1905. In 1915 he was a member of the International Jury of Awards, Department of Transportation of the Panama-Pacific International Exposition. In recognition of his work in transportation incident to these expositions he was given the honors of Chevalier, Legion of Honor, France, 1901; Royal Order of the Crown, Germany, 1905, and Imperial Order of the Rising Sun, Japan, 1905. He was a trustee of the University of Chicago from 1904 until a few months ago when he resigned on account of failing health. He was also honorary curator of the World Columbian Museum of Natural History at Chicago.

George R. Huntington, president of the Minneapolis, St. Paul & Sault St. Marie Railway and the Wisconsin Central Railway, died at Minneapolis, Minn., November 4, at the age of 55 years.

George Chadbourne Taylor, president of the American Railway Express Company, died at his home at Pelham Heights, New York, on November 18.

E. O. McCormick, vice-president of the Southern Pacific Co., with headquarters at San Francisco, Calif., died of heart ailment at his home in San Francisco, Calif., November 1st.

C. W. Kates, general manager of the Escanaba & Lake Superior Railroad, with headquarters at Wells, Mich., **died** on November 12.

William J. Bohan, assistant general mechanical superintendent of the Northern Pacific Railway, died October 28, at St. Paul, Minn.

H. R. Carpenter, assistant chief engineer of the Missouri Pacific Railroad, with headquarters at St. Louis, Mo., died suddenly in St. Louis, Mo., on November 12.

J. E. Brogdon, superintendent of motive power for the Atlantic Coast Line Railroad, with headquarters at Waycross, Ga., died at the Coast Line Hospital in that city the latter part of October.

New Publications

Books, Bulletins, Catalogues, Etc.

The Annual Universal Directory of Railway Officials, 29th edition compiled and edited by the editor of The Railway Gazette, London, England, is published later than usual this year in order to include the numerous changes in personnel, following the grouping of the British Railways. This publication contains a complete list of all the chief railway officials all over the world. The directory is divided as follows: Official Great Britain, Ireland, Europe, Asia, Africa, Australasia, North American, Central American, Mexico, and West Indies, South America and a Personal Index of Railway Officials.

The Pyle National Company, Chicago, Ill. have issued a new bulletin, Pyle-O-Lyte, known as catalog No. 4, contains 28 pages, illustrating and describing the application of the Pyle National equipment to the various phases of railway and construction lighting. There are many diagrams and photographs showing the different types of lighting units, together with the specifications for each. A portion of the bulletin is devoted to the explanation of floodlighting calculations which is clearly set forth by diagrams and sample calculations fully explained and worked out. The different types of Pyle National turbo generators are illustrated ranging in capacity from 500 watts to 7/12 k.w., and steam turbines for various purposes ranging in speed from 2,000 to 5,000 r.p.m. and for ½ hp. to 12½hp. are also shown.

Proceeding of the Master Boiler Makers' Association 1923. Edited by the secretary, Harry D. Vought, 26 Cortlandt Street, New York, N. Y. 120 pages, 6 in. by 9 in. bound in cloth. This book contains the proceeding of the convention of the Master Boiler Makers' Association which was held in Chicago, Ill., May 22-23. Committee reports together with the discussions of the following subjects appear in the volume: Hammer Testing of Staybolts; Maintaining Combustion Chamber Boilers; Finished Plates; Detecting Defective Boiler Sheets; Automatic Stokers; Method of Applying Flues; Life of Superheater Tubes; Steam Leaks; Recommended Practice, and Care of Stationary Boilers.

Boiler Feed Pumps and Feed Water Heater. The Worthington Pump and Machinery Corporation, New York, have recently issued bulletin B-1607-B, descriptive of the construction and operation of the Worthington feed water pump and feed water heater. The Bulletin is well illustrated, colored diagrams being used to show the methods of operation. Particulars are given showing the heat and coal saving characteristics of the feed water heater are shown in curves. A table of the properties of steam is also given and examples illustrating its use in calculating the reduction in the amount of heat required to generate the steam, the amount of steam required for heating and the amount of water saved by the Worthington locomotive feed water heater.

Electric Headlights. A 12-page booklet entitled "Electric Headlights" has recently been issued by the Sunbeam Electric Manufacturing Company, Evansville, Ind., which illustrates and describes the locomotive headlight, industrial headlight, and floodlights manufactured by that company. The booklet also describes the focusing device used in conjunction with the air-tight, silver-plated, metal reflectors.

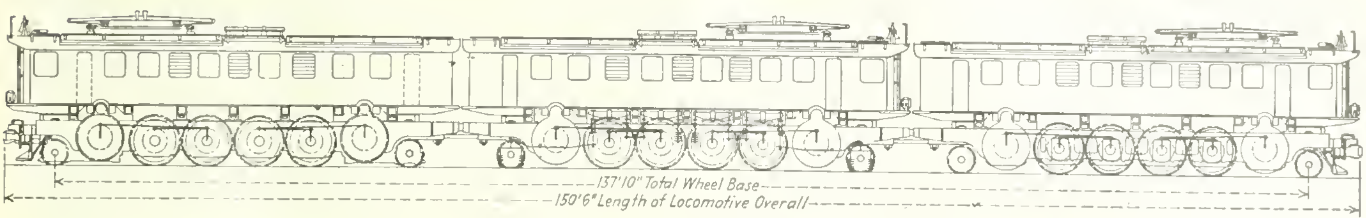
Tentative Standards American Society for Testing Materials. These tentative standards are published annually and the 1923 edition which has been recently issued is a volume of 859 pages. It contains the specifications for 170 tentative standards covering a very wide range of materials. These materials include steel, wrought and cast iron, non-ferrous metals, cement, lime, gypsum and clay products, preservative coatings and lubricants, road materials, coal and coke timber, water proofing, insulating containers, rubber products, textile materials and thermometers.

These tentative standards are distinguished from standards in that the term is applied to a proposed standard which is printed for one or more years for the purpose of eliciting criticism of which the committee having charge of the matter will take due cognizance before recommending final action toward the adoption of such tentative standards as standards by the society.

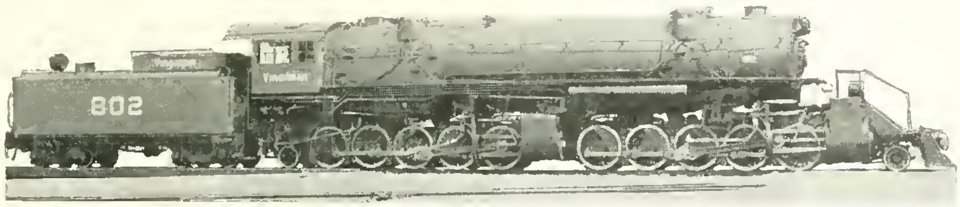
The volume under consideration, then, is occupied with specifications which bear the same relationship to full standards as the recommended practice of the Mechanical Section of the American Railway Association bears to its standards.

Charcoal Iron Boiler Tubes. The Parkesburg Iron Company, Parkesburg, Pa., have recently issued a very interesting illustrated booklet of 52 pages describing the Parkesburg process of manufacturing charcoal iron boiler tubes and also the rigid inspection that is given the finished product. Some instances are given of the high resistance qualities of charcoal iron boiler tubes and also the long life of some in service. The physical properties of charcoal iron is dealt with in the introduction. Reference is also made to another of the company's publications, "Recommended Practice for the Application and Maintenance of Charcoal Iron Boiler Tubes, Arch Tubes and Superheater Flues." Anyone having to do with the application, maintenance or purchase of boiler tubes may have copies of the above mentioned booklets on application to The Parkesburg Iron Company.

On The Virginian



Virginian Electric Locomotive to be Alco Built, will be the largest and most powerful locomotive in the world



Virginian Engine 802, Alco Built, is the largest and most powerful steam locomotive

In a project so vast as the electrification of the Virginian it is obvious that the choice of equipment was considered of the first importance. To obtain the utmost in structural perfection was the foremost demand.

While the Virginian paid an eloquent tribute to the excellence of Alco built locomotives in specifying them for this service, there is conveyed an even larger significance in their selection, which should be of strong and especial interest to users of similar equipment.

This endorsement bespeaks confidence in the unfailing quality of Alco construction demonstrated over a span of years on this road, and in a very profound sense, expresses abiding faith in Alco service which time serves merely to strengthen.

AMERICAN LOCOMOTIVE COMPANY

30 Church Street **New York City**

Multiple-Unit Train of the Long Island Railroad

Handling New York's Suburban Traffic

Passengers and freight carried by
the Long Island Railroad during:

1905	1922
Passengers: 18,000,000	**Passengers: 79,656,891**
Freight: 2,745,000 tons	**Freight: 6,027,860 tons**

The Long Island was electrified in 1905 and is now operating 494 multiple-unit cars equipped with Westinghouse Motors and Electro-Pneumatic Control.

To take care of increasing traffic and to maintain its high standard of service, 104 new equipments of Westinghouse No. 308 Motors and electro-pneumatic control have been purchased, thereby increasing the number of motor cars 21%, and furnishing 8300 additional seats for the traveling public.

Westinghouse Electric & Manufacturing Company

East Pittsburgh, Pennsylvania

Sales Offices in All Principal Cities of the United States and Foreign Cities

W WESTINGHOUSE ELECTRIC

Westinghouse

ONE ORDER OF AMERICAN SEMI-PLUG VALVES READY FOR SHIPMENT

Buyers' Directory

Acetylene—Dissolved.
Linde Air Products Co., New York.

Air Brake Fittings.
Western Ry. Equipment Co., St. Louis.
Westinghouse Air Brake Co., Wilmerding, Pa.

Air Brake, Hose.
Westinghouse Air Brake Co., Wilmerding, Pa.
Garlock Packing Co., Palmyra, N. Y.

Air Brakes.
Westinghouse Air Brake Co., Wilmerding, Pa.

Air Compressors.
Westinghouse Air Brake Co., Wilmerding, Pa.

Anvils.
Hay-Budden Mfg. Co., Brooklyn, N. Y.

Arches, Locomotive Firebox.
American Arch Co., New York.

Asbestos.
Johns-Manville, Inc., New York.

Ash Pans, Cast Steel.
Commonwealth Steel Co., St. Louis.

Automatic Dies.
Landis Machine Co., Waynesboro, Pa.

Axles, Car and Locomotive.
American Locomotive Co., New York.
Baldwin Locomotive Works, Philadelphia.
Gould Coupler Co., New York.

Balanced Main Valves, Slide and Piston.
Young, C. C., Jersey Shore, Pa.

Ballast Cars.
Pressed Steel Car Co., Pittsburgh.

Batteries, Electric Storage.
Gould Coupler Co., New York.
Safety Car Heating & Lighting Co., New York.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Bearings, Center and Side.
National Malleable Castings Co., Cleveland.

Boiler Compounds.
Dearborn Chemical Co., Chicago.
Johns-Manville, Inc., New York.

Boiler Shop Machinery.
Landis Machine Co., Waynesboro, Pa.
Sellers & Co., Inc., Wm., Philadelphia.

Boiler Washout System.
National Boiler Washing Co., Chicago.

Boilers, Locomotive.
American Locomotive Co., New York.
Baldwin Locomotive Works, Philadelphia, Pa.

Bolster Steel.
Commonwealth Steel Co., St. Louis.
Gould Coupler Co., New York.
Pressed Steel Car Co., Pittsburgh.
Standard Car Truck Co., Chicago.

Bolt and Nut Machines.
Landis Machine Co., Waynesboro, Pa.

Bolt Cutters and Headers.
Acme Machinery Co., Cleveland.
Landis Machine Co., Waynesboro, Pa.

Bolt Dies.
Landis Machine Co., Waynesboro, Pa.

Bolt Threading Machines.
Acme Machinery Co., Cleveland.
Landis Machine Co., Waynesboro, Pa.

Bonds—Rail.
Johns-Manville, Inc., New York.

Books.
Angus Sinclair Co., 114 Liberty St., N. Y.
Audel & Co., Theo., New York.

Boosters, Locomotive.
Franklin Railway Supply Co., Inc., New York.

Boring Bars, Expansion.
Davis Boring Tool Co., St. Louis.

Boring Machines.
Acme Machinery Co., Cleveland.

Boring Machines, Car Wheel.
Sellers & Co., Inc., Wm., Philadelphia.

Boring Machines, Cylinder.
Sellers & Co., Inc., Wm., Philadelphia.

Boring and Turning Tools.
Sellers & Co., Inc., Wm., Philadelphia.

Boring Tools, Expansion.
Davis Boring Tool Co., St. Louis.

Brakebeams.
Pressed Steel Car Co., Pittsburgh.

Brake Jaws and Levers.
National Malleable Castings Co., Cleveland.
Western Railway Equip. Co., St. Louis.

Brake Levers.
National Malleable Castings Co., Cleveland.
Westinghouse Air Brake Co., Wilmerding, Pa.

Brake Pins.
Westinghouse Air Brake Co., Wilmerding, Pa.

Brakes, Air.
Westinghouse Air Brake Co., Wilmerding, Pa.

Brakeshoes.
Am. Brake Shoe & Foundry Co., New York.
National Malleable Castings Co., Cleveland.

Building Paper.
Johns-Manville, Inc., New York.

Buffers, Friction.
Westinghouse Air Brake Co., Wilmerding, Pa.

Buffers, Radial.
Franklin Railway Supply Co., Inc., New York.

Car Axles.
Gould Coupler Co., New York.

Car Chart.
Angus Sinclair Co., 114 Liberty St., N. Y.

Car Couplers—(See Couplers).

Car Door Fasteners.
National Malleable Castings Co., Cleveland.

Car Heating.
Gold Car Heating & Ltg. Co., Brooklyn, N. Y.
Johns-Manville, Inc., New York.
Safety Car Heating & Lighting Co., New York.
Vapor Car Heating Co., Chicago.

Car Lighting.
Franklin Railway Supply Co., Inc., New York.
General Electric Co., Schenectady, N. Y.
Gold Car Heating & Ltg. Co., Brooklyn, N. Y.
Gould Coupler Co., New York.
Safety Car Heating & Lighting Co., New York.
Vapor Car Heating Co., Chicago.

Carlines.
Western Railway Equipment Co., St. Louis.

Car Platform Steel.
Commonwealth Steel Co., St. Louis.
Gould Coupler Co., New York.
McConway & Torley Co., Pittsburgh.
Standard Coupler Co., New York.

Car Roofs.
Johns-Manville, Inc., New York.

Car Springs.
Pittsburgh Spring & Steel Co., Pittsburgh.

Car Trucks.
Commonwealth Steel Co., St. Louis.
Pressed Steel Car Co., Pittsburgh.
Standard Car Truck Co., Chicago.

Buyers' Directory

Car Wheel Expansion Boring Tools.
Davis Baring Tool Co., St. Louis.

Cars, Ballast.
Pressed Steel Car Co., Pittsburgh.

Cars, Dumping.
Pressed Steel Car Co., Pittsburgh.

Cars, Freight.
American Car & Fdy. Co., New York.
Pressed Steel Car Co., Pittsburgh.

Cars, Pressed Steel.
Pressed Steel Car Co., Pittsburgh.

Cars, Steel.
American Car & Foundry Co., New York.
Pressed Steel Car Co., Pittsburgh.

Cars, Tank.
Pressed Steel Car Co., Pittsburgh.

Castings, Iron and Steel.
American Locomotive Co., New York.
Am. Brake Shoe & Fdy. Co., Chicago.
Commonwealth Steel Co., St. Louis.
Gould Coupler Co., New York.
Hunt-Spiller Mfg. Corp., Boston.
National Malleable Castings Co., Cleveland.

Castings, Malleable Iron.
Gould Coupler Co., New York.
National Malleable Castings Co., Cleveland.

Cement, Asbestos.
Johns-Manville, Inc., New York.

Center Plates.
Gould Coupler Co., New York.
Standard Car Truck Co., Chicago.

Chain Iron.
Penn Iron & Steel Co., Pittsburgh.

Circuit-Breakers.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Closets, Car.
Duner Car Closet Co., Chicago.
Johns-Manville, Inc., New York.

Cocks, Angle.
Westinghouse Air Brake Co., Wilmerding, Pa.

Conduits, Flexible.
Franklin Railway Supply Co., Inc., New York.

Connectors.
American Automatic Connector Co., Cleveland.
Westinghouse Air Brake Co., Wilmerding, Pa.

Cordage.
Johns-Manville, Inc., New York.

Couplers, Automatic Car and Air.
Westinghouse Air Brake Co., Wilmerding, Pa.

Couplers, Car.
American Locomotive Co., New York.
Franklin Railway Supply Co., Inc., New York.
Gould Coupler Co., New York.
McConway & Torley Co., Pittsburgh.
National Malleable Castings Co., Cleveland.
Westinghouse Air Brake Co., Wilmerding, Pa.

Couplers, Pilot.
Gould Coupler Co., New York.

Couplings, Shaft.
Sellers & Co., Inc., Wm., Philadelphia.

Die Heads.
Landis Machine Co., Waynesboro, Pa.
Rickert-Shafer Co., Erie, Pa.

Dies.
Landis Machine Co., Waynesboro, Pa.
Saunders' Sons, Inc., D., Yonkers, N. Y.

Dies, Pipe.
Saunders' Sons Co., D., Yonkers, N. Y.

Doors, Freight Car.
Western Railway Equipment Co., St. Louis.

Doors, Locomotive Firebox.
Franklin Railway Supply Co., Inc., New York.

Draft Gears.
Westinghouse Air Brake Co., Wilmerding, Pa.

Draft Rigging and Attachments.
Commonwealth Steel Co., St. Louis.
Gould Coupler Co., New York.
National Malleable Castings Co., Cleveland.
Western Railway Equipment Co., St. Louis.
Westinghouse Air Brake Co., Pittsburgh.

Drilling Machines.
Sellers & Co., Inc., Wm., Philadelphia

Driving Boxes.
Franklin Railway Supply Co., Inc., New York.

Dust Guards.
Gould Coupler Co., New York.
Western Ry. Equipment Co., St. Louis.

Dynamos.
Westinghouse Electric & Mfg. Co., Pittsburgh.

Electric Car Lighting.
Gould Coupler Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburgh.

Electric Generators and Motors.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Electric Headlights.
Pyle National Company, Chicago.

Electric Rivet Heaters.
American Car & Foundry Co., New York.

Engine Bolt Iron.
Penn Iron & Steel Co., Pittsburgh.

Engine Lathes.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.

Fans, Electric.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Fire Boxes.
American Locomotive Co., New York.
Baldwin Locomotive Works, Philadelphia.

Fire Doors, Automatic.
Franklin Railway Supply Co., Inc., New York.

Flexible Joints.
Franklin Railway Supply Co., Inc., New York.

Flue Cleaners.
Johns-Manville, Inc., New York.

Forging Machinery.
Acme Machinery Co., Cleveland.

Buyers' Directory

Forgings.
Acme Machinery Co., Cleveland.
American Locomotive Co., New York.
Gould Coupler Co., New York.

Frames, Truck.
American Locomotive Co., New York.
Commonwealth Steel Co., St. Louis.
Franklin Railway Supply Co., Inc., New York.
Pressed Steel Car Co., Pittsburgh.
Western Railway Equipment Co., St. Louis.

Friction Buffers.
Gould Coupler Co., New York.
Westinghouse Air Brake Co., Wilmerding, Pa.

Fuel Oils.
Galena-Signal Oil Co., Franklin, Pa.

Gaskets.
Westinghouse Air Brake Co., Wilmerding, Pa.
Johns-Manville, Inc., New York.

Gauges.
Ashton Valve Co., Boston.
Gold Car Heating & Lighting Co., New York.

Graphite, Lubricating.
Galena-Signal Oil Co., Franklin, Pa.

Grate Shakers.
Franklin Ry. Supply Co., Inc., New York.

Grease.
Galena-Signal Oil Co., Franklin, Pa.

Grease Forming Machines.
Franklin Ry. Supply Co., Inc., New York.

Grinding Machines.
Landis Machine Co., Waynesboro, Pa.

Grinding Materials.
Pittsburgh Crushed Steel Co., Pittsburgh.

Hammers, Steam.
Sellers, & Co., Inc., Wm., Philadelphia.

Hand Brakes.
Minich Railway Appliance Corporation, Philadelphia.

Hangers, Shaft.
Sellers & Co., Inc., Wm., Philadelphia.

Headlights.
Pyle National Company, Chicago.

Heating Systems, Car.
Gold Car Heating & Ltg. Co., Brooklyn, N. Y.
Johns-Manville, Inc., New York.
Safety Car Htg. & Ltg. Co., New York.
Vapor Car Heating Co., Chicago.

High Speed Steel.
Vanadium Alloys Steel Co., Latrobe, Pa.

Hoists, Electric.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Hose.
Garlock Packing Co., Palmyra, N. Y.
Gold Car Heating & Lighting Co., New York.

Hose, Air.
Westinghouse Air Brake Co., Wilmerding, Pa.

Hose Couplings.
National Malleable Castings Co., Cleveland.
Vapor Car Heating Co., Chicago.
Westinghouse Air Brake Co., Wilmerding, Pa.

Hydraulic Tools and Machinery.
Niles-Bement-Pond Co., New York.
Wood, Wm. H., Loco. Firebox Co., Media, Pa.

Indicators, Steam Engine.
Hunt-Spiller Mfg. Corp., Boston.
National Malleable Castings Co., Cleveland.

Injectors.
Sellers & Co., Inc., Wm., Philadelphia.

Injectors for Testing Boilers.
Rue Mfg. Co., Philadelphia.
Sellers & Co., Inc., Wm., Philadelphia.

Insulating Material.
Johns-Manville, Inc., New York.

Iron and Steel—(See also Steel).
Hunt-Spiller Mfg. Corp., Boston.
Penn Iron & Steel Co., Pittsburgh.

Joints, Flexible.
Franklin Railway Supply Co., Inc., New York.

Journal Boxes and Lids.
Amer. Brake Shoe & Foundry Co., New York.
Gould Coupler Co., New York.
National Malleable Castings Co., Cleveland.

Lamps, Incandescent.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Lamps, Tungsten.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Lathes.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia.

Lock Nuts & Washers.
Franklin Railway Supply Co., Inc., New York.
Standard Safety Nut Corporation, New York.

Locomotive Boiler Washing.
National Boiler Washing Co., Chicago.

Locomotive Charts.
Angus Sinclair Co., 114 Liberty St., New York.

Locomotive Contractors.
American Locomotive Co., New York.
Baldwin Locomotive Works, Philadelphia.

Locomotive Driving Wheel Centers.
American Steel Foundries, New York.
Commonwealth Steel Co., St. Louis.

Locomotive Fireboxes.
American Locomotive Company, New York.
Baldwin Locomotive Works, Philadelphia.

Locomotive Injectors.
Sellers & Co., Inc., Wm., Philadelphia.

Locomotive Lagging.
Johns-Manville, Inc., New York.

Locomotive Packing.
Garlock Packing Co., Palmyra, N. Y.

Locomotive Paint.
Dixon, Joseph, Crucible Co., Jersey City, N. J.

Locomotive Reverse Gears.
Franklin Railway Supply Co., Inc., New York.

Locomotive Rod Boring Machines.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia.

Locomotive Stokers.
Elvin Mechanical Stoker Co., New York.
Hanna Locomotive Stoker Co., Cincinnati.
Locomotive Stoker Co., Pittsburgh.

Locomotive Valve Gears.
Pyle National Company, Chicago.

Locomotives.
American Locomotive Co., New York.
Baldwin Locomotive Works, Philadelphia.

Locomotive Valves.
Sellers & Co., Inc., Wm., Philadelphia.

Locomotives, Compressed Air.
Baldwin Locomotive Works, Philadelphia.

Locomotives, Electric.
American Locomotive Co., New York.
Baldwin Locomotive Works, Philadelphia.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Locomotives, Mine.
American Locomotive Co., New York.
Baldwin Locomotive Works, Philadelphia.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Lubricants.
Galena-Signal Oil Co., Franklin, Pa.
The Texas Co., New York.

Lubricators.
The Collins Metallic Packing Co., Philadelphia.
Franklin Railway Supply Co., Inc., New York.

Lubricators, Locomotive.
Franklin Railway Supply Co., Inc., New York.
Locomotive Lubricator Co., Chicago.

Lumber—Asbestos.
Johns-Manville, Inc., New York.

Machine Tools.
Acme Machinery Co., Cleveland.
Landis Machine Co., Waynesboro, Pa.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Sellers & Co., Inc., Wm., Philadelphia.

Magnesia Products.
Johns-Manville, Inc., New York.

Metallic Packing.
Garlock Packing Co., Palmyra, N. Y.
Young, C. C., Jersey Shore, Pa.

Nitrogen.
Linde Air Products Co., New York.

Nitrogen Gas.
Linde Air Products Co., New York.

Nozzles, Exhaust.
Franklin Railway Supply Co., Inc., New York.

Nut Locks.
Franklin Railway Supply Co., Inc., New York.
Standard Safety Nut Corporation, New York.

Nut Machines.
Acme Machinery Co., Cleveland.
Landis Machine Co., Waynesboro, Pa.

Buyers' Directory

Nuts, Square and Hexagon.
Franklin Railway Supply Co., Inc., New York.
Standard Safety Nut Corporation, New York.

Oils.
Galena-Signal Oil Co., Franklin, Pa.
The Texas Company, New York.

Oxy-Acetylene Process.
Linde Air Products Co., New York.

Oxygen.
Linde Air Products Co., New York.

Oxygen Gas.
Linde Air Products Co., New York.

Packing, Asbestos.
Johns-Manville, Inc., New York.

Packing, Metallic.
The Collins Metallic Packing Co., Philadelphia.
Garlock Packing Co., Palmyra, N. Y.

Packing Pumps.
Garlock Packing Co., Palmyra, N. Y.
Johns-Manville, Inc., New York.

Packing Rings.
Johns-Manville, Inc., New York.

Pins, Crank.
American Locomotive Co., New York.
Baldwin Locomotive Works, Philadelphia.

Pintsch Gas.
Safety Car Heating & Lighting Co., New York.

Pipe and Boiler Coverings.
Johns-Manville, Inc., New York.

Pipe Clamps.
Franklin Railway Supply Co., Inc., New York.

Pipe Dies.
Landis Machine Co., Waynesboro, Pa.
Saunders' Sons, Inc., D., Yonkers, N. Y.

Pipe, Iron.
American Car & Foundry Co., New York.

Pipe Threading and Cutting Machinery.
Landis Machine Co., Waynesboro, Pa.
Saunders' Sons, Inc., D., Yonkers, N. Y.

Piston Valves, Semi-Plug.
Young, C. C., Jersey Shore, Pa.

Planing Machines (Metal).
Sellers & Co., Inc., Wm., Philadelphia.

Platforms, Steel.
Commonwealth Steel Co., St. Louis.
Gould Coupler Co., New York.
McConway & Torley Co., Pittsburgh.
Standard Coupler Co., New York.

Reamers, Expansion.
Davis Boring Tool Co., St. Louis, Mo.

Reamers, Adjustable.
Davis Boring Tool Co., St. Louis, Mo.

Reamers, High Speed.
Davis Boring Tool Co., St. Louis, Mo.

Regulators, Electric.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Reverse Gears, Power.
Franklin Railway Supply Co., Inc., New York.

Rheostats.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Rivet Headers.
Acme Machinery Co., Cleveland.

Rivet Heaters, Electric.
American Car & Foundry Co., New York.

Roofing—Asbestos.
Johns-Manville, Inc., New York.

Roofing—Prepared.
Johns-Manville, Inc., New York.

Screw Cutting Dies.
Landis Machine Co., Waynesboro, Pa.

Shafting.
Sellers & Co., Inc., Wm., Philadelphia.

Signal Oils.
Galena-Signal Oil Co., Franklin, Pa.
The Texas Company, New York.

Slack Adjusters.
Gould Coupler Co., New York.
Westinghouse Air Brake Co., Wilmerding, Pa.

Slotting Machines.
Sellers & Co., Inc., Wm., Philadelphia.

Staybolt Dies.
Landis Machine Co., Waynesboro, Pa.

Staybolt Iron.
Penn Iron & Steel Co., Pittsburgh.

Staybolt Threading Machines.
Acme Machinery Co., Cleveland.
Landis Machine Co., Waynesboro, Pa.

Staybolts.
American Locomotive Co., New York.
Flannery Bolt Co., Pittsburgh.

Staybolts, Flexible.
Flannery Bolt Co., Pittsburgh.

Staybolts, Iron and Steel.
Flannery Bolt Co., Pittsburgh.

Steam Chests.
Franklin Railway Supply Co., Inc., New York.

Steam Couplers.
Gold Car Heating & Ltg. Co., Brooklyn, N. Y.
Safety Car Heating & Lighting Co., New York.

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Steel, Crushed.
Pittsburgh Crushed Steel Co., Pittsburgh.

Steel, Emery.
Pittsburgh Crushed Steel Co., Pittsburgh.

Steel Staybolts.
American Locomotive Co., New York.

Stokers, Locomotive.
Elvin Mechanical Stoker Co., New York.
Hanna Locomotive Stoker Co., Cincinnati.
Locomotive Stoker Co., New York.

Switchboards.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Switches, Electric.
Westinghouse Elec. & Mfg. Co., Pittsburgh.

Syphons, Locomotive Firebox.
Locomotive Firebox Company, Chicago.

Trucks, Car and Locomotive.
American Locomotive Co., New York.
Commonwealth Steel Co., St. Louis.
Franklin Railway Supply Co., Inc., New York.
McConway & Torley Co., Pittsburgh.
Pressed Steel Car Co., Pittsburgh.
Standard Car Truck Co., Chicago.

Trucks, Electric.
American Locomotive Co., New York.

Trucks, Engine and Tender.
Franklin Railway Supply Co., Inc., New York.

Turntable Tractors.
Nichols, Geo. P. & Bro., Chicago.

Turntables.
Nichols, Geo. F., & Bro., Chicago.

Underframes, Steel.
Commonwealth Steel Co., St. Louis.

Valves, Pop, Safety, and Relief.
Westinghouse Air Brake Co., Wilmerding, Pa

Valves, Pressure Regulating.
Gold Car Heating & Ltg. Co., Brooklyn, N. Y.
Vapor Car Heating Co., Chicago.

Ventilators, Car.
Globe Ventilator Co., Troy, N. Y.
Gold Car Heating & Ltg. Co., Brooklyn, N. Y.
Vapor Car Heating Co., Chicago.

Vestibules, Passenger Car.
Gould Coupler Co., New York.
McConway & Torley Co., Pittsburgh.

Vulcabeston.
Johns-Manville, Inc., New York.

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Dearborn Chemical Co., Chicago.

Wedges, Automatic.
Franklin Railway Supply Co., Inc., New York.

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American Locomotive Co., New York.
Westinghouse Air Brake Co., Wilmerding, Pa.

Tanks, Water.
American Locomotive Co., New York.

Taps and Dies.
Landis Machine Co., Waynesboro, Pa.

Threading Tools.
Landis Machine Co., Waynesboro, Pa.
Rickert-Shafer Co., Erie, Pa.

Transfer Tables.
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Truck Frames.
American Steel Foundries, New York.
Commonwealth Steel Co., St. Louis.
Franklin Ry. Supply Co., Inc., New York.
Gould Coupler Co., New York.
Pressed Steel Car Co., Pittsburgh.
Standard Car Truck Co., Chicago.

Upsetting Machines.
Acme Machinery Co., Cleveland.

Valve Chests.
Franklin Railway Supply Co., Inc., New York.
Pyle National Company, Chicago.

Valve Gears.
Pyle National Company, Chicago.

Valve Grinding Material.
Pittsburgh Crushed Steel Co., Pittsburgh.

Valves.
American Car & Foundry Co., New York.
Franklin Railway Supply Co., Inc., New York.
Gold Car Heating & Ltg. Co., Brooklyn, N. Y.
Homestead Valve Mfg. Co., Homestead, Pa.
Westinghouse Air Brake Co., Wilmerding, Pa.

Valves, Balanced Slide and Piston.
Franklin Railway Supply Co., Inc., New York.
Pyle National Company, Chicago.
Young, C. C., Jersey Shore, Pa.

Valves, Drifting.
Franklin Railway Supply Co., Inc., New York.
Sellers & Co., Inc., Wm., Philadelphia

Welders, Electric.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh.

Welding Equipment.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh.

Wheel Centers, Driving.
American Locomotive Co., New York.
Commonwealth Steel Co., St. Louis.
Hunt-Spiller Mfg. Corp., Boston.

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Association of Mfrs. of Chilled Car Wheels, Chicago.
Baldwin Locomotive Works, Philadelphia.
Pressed Steel Car Company, Pittsburgh.

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