Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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Most Powerful Prime Mover in the World

The Interborough Rapid Transit Company, New York, has recently placed in operation at its 74th Street Power House, a Westinghouse turbine that is remarkable for two reasons.

Secondly, it has three elements, one high pressure and two low pressure, and it is the first triple cross-compound turbine to be placed in operation.

The purpose of this huge machine is to

NEW 70,000 K. W TURBINE OF THE INTERBOROUGH RAPID TRANSIT COMPANY.

It is, in the first place, rated at 60,000 K.W. capacity continuously, and 70,000 K.W. for two hours, so it is, therefore, the most powerful prime mover in the world.

assist in meeting the greatly increased demand for transportation in New York City, due to the opening up of a new subway system, and the extension of the service of the existing subway, elevated and subway lines. The rapidity with which the Interborough's power requirements have increased in the past few years is indeed extraordinary. In 1904 the 74th Street Station contained nine reciprocating engines driving direct-current generators rated at 5000 K.W., each. This amount of power sufficed for a while, and then in 1913, it became necessary to remove four of these engines and install in their place, three compound 30,000 K.W. turbines. Though 90,000 K.W. was thus substituted for 20,000 K.W., this increase was hardly obtained when it, in turn became insufficient. Now, 70,000 K.W. more is added, and probably additional units will again be needed in the not distant future.

The new unit occupies a floor space of 52 x 50 ft., and is about 19 feet high. The high pressure element receives steam at 205 lbs. gauge pressure, and superheated 150° F., and exhausts it into the low pressure elements at 15 lbs. gauge pressure. The two low pressure elements are identical in construction, and each receives one-half of the steam from the high pressure element and exhausts it into the condenser where a 29 in. vacuum is maintained. All three elements operate at 1500 r.p.m., and each drives a generator rated at 20,000 K.W. continuously, 23,500 K.W. for two hours, and 30,000 K.W. for a half hour. The generators deliver three-phase, 25-cycle, 11,000 volt alternating current.

The Turbines

Though consisting of three separate elements, the entire machine is started, synchronized, and controlled as a single unit. At the same time, any one or two of the elements can be shut down without interferring with the remainder, so that the high efficiency of a single large machine is combined with the flexibility of three smaller machines. In addition, the three small elements are mechanically much stronger than a single large one would be; the temperature differences in any cylinder are considerably less, and commercially common materials, with moderate blade speeds and stresses, can be used.

All of the turbines are of the pure reaction type, without the usual impulse elements, as this construction is considered preferable in view of the great volumes of steam to be handled. The high pressure turbine is of the single-flow type, and is made of cast steel. The low pressure turbines are of the semi-double flow type; that is, the steam enters near the center of the turbine and flows as a whole through a portion of the blading, and then divides into two portions, each of which flows through a separate section into the condenser. Since the low pressure turbine must receive high pressure steam in case the high pressure turbine is shut down, the central portions of these turbines are made of cast steel also. All three rotors are equipped with Kingsbury thrust bearings, in order to prevent axial movement.

The Generators

The generators are so connected to the bus bars that any combination of them can be operated in parallel. In practice, however, all three are brought up to speed together, and synchronized through a single oil-switch connecting the generator busses to the main bus. Reactance coils are installed between the various busses, which limit the amount of current that can flow between the generators. Should a short circuit develop in any of the feeder circuits, or a burn-out occur within a generator, the generator affected is disconnected from the busses by a circuit breaker without interfering with the operation of the other generators.

The method of synchronizing the generators is as follows: The field current is first applied to all of the generators, and then the throttle valve of the high pressure turbine is partly opened. As soon as the high pressure rotor starts revolving, it will start the rotors of the low pressure turbines through the field current. All three then come up to speed together in correct phase with each other. They are then synchronized with the system, and connected to it by closing a single circuit breaker.

The Governor

The governing mechanism must not only control the unit as whole, but also each turbine operating separately. Some of the operations performed by the governors are as follows:

If serious electrical trouble develops on the circuit of one of the generators of the low pressure turbines, a circuit breaker will disconnect this generator from the bus bar. Relieved of load, the turbine begins to speed up, but before its speed has increased four per cent, its governor shuts off the steam supply from the high pressure turbine. This, of course, raises the back pressure of the high pressure turbine, and a back-pressure valve opens allowing part of the exhaust from the high pressure turbine to pass into the atmosphere, while the remainder goes into the other low pressure turbine.

In the mean time, the first low pressure turbine, being without steam, shuts down. When its speed reaches three per cent below normal, the governor admits high pressure steam, and the turbine continues to operate at this speed until the switchboard operator either shuts it down or restores normal conditions. Should the generator of the high pressure turbine be cut out of circuit, the governor cuts off practically all the steam to the entire system, leaving just a sufficient flow to maintain the speed of the high pressure turbine now without load. The speed of the two pressure turbines decreases, and when the frequency drops three per cent, the governor admits high pressure steam direct to the low pressure turbines, which then continue operating. The switchboard operator can now either restore matters to normal or shut down the high pressure turbine.

Each turbine also has an emergency stop, which will operate automatically in case the governor fails and the turbine begins to race, or it can be tripped by the switchboard operator. When one of the turbines fails with the entire unit heavily loaded, the governors permit each of the remaining turbines to carry the maximum load of 30,000 K.W. This can be maintained for a half hour, which is regarded as sufficient time to get other generators into operation, and thus relieve the overloaded turbine.

Condensers

The condenser equipment consists of two 25,000 square-foot surface condensers for each low pressure turbine. There are four circulating pumps, three Le Blanc air pumps, and four condensate pumps. All of these pumps are turbine driven (the air pumps directly and the others through gears), and all are so arranged that one or more can be put out of service without interfering with the operation of the condenser.

Performance

The steam consumption of the entire unit at its point of best efficiency is 10.7 lbs. per kilowatt hour. The pressure turbine and one low pressure turbine, operating together, consume 12 lbs. of steam per kilowatt hour; and one low-pressure turbine alone consumes 14.25 lbs. The total steam consumption at full load is 826,000 lbs. per hour.

The Alaskan Railroad.

When it became apparent that the Alaskan Engineering Commission would be unable to complete the Alaskan Railroad with the original appropriation of $35,000,000, a new bill was introduced into the House appropriating an additional $17,000,000 for this work.

The greatest expense yet to be met is for new work on various sections. One of the heavy items of expense will be the bridge over the Tanana river, which, it is estimated, will cost $1,220,298. Approximately $14,000,000 of the proposed appropriation is required for new work; the remainder is for reconstructing the Alaska Northern Railway, rehabilitating the Chatanika branch, constructing terminals and bridges, and for rolling stock and expenses in excess of revenue.

Investigations of the committee indicated that in addition to the mineral resources of Alaska, which this road will open up, there is every prospect of Alaska becoming an important producer of agricultural crops. Investigation further developed that private capital had probably not built a line through this country because the government owns 99 per cent of the area of Alaska, which makes the government the logical interest to construct such a railway.

The work has been proceeded with so far very creditably, and every assurance of a continuation.

Fire Fighting Car, Duluth, South Shore & Atlantic Ry.

By John Herron, Marquette, Mich.

Fires along the right of way of railway lines, especially in thinly-settled localities, are serious matters and the cause of much anxiety to officers and loss of property. To meet this condition the Duluth, South Shore & Atlantic Railway has built, or rather rebuilt, an old tank car into a very efficient fire-fighting machine. The tank was reclaimed after it had been through a fire, and fitted with platform and railings about the dome and then mounted on an underframe and trucks.

The car is fitted with two duplex pumps and has both steam and water connections at each end. The tool and supply boxes carry a complete outfit of nozzles, wrenches and other necessary tools, as well as 1,000 ft. of 2½-in. water hose.

At present the car is all that there is of the fire-fighting plant; but, owing to the efficiency of its operation and the value of the work that was done during the past season, it is the intention to have an equipment car fitted up for the use and accommodation of the crew when it is out on the road.

As a large proportion of the engines of the road are fitted with a hose connection on the injector discharge pipe, and also carry a length of water hose, the combination of this car and a locomotive makes it possible to play three streams of water on a fire at the same time. In the illustration, it will be seen that one stream only is at work from the car, the other being shut off.

The upper peninsula of Michigan has been the scene of some of the worst forest fires in the history of the country, and the past summer has been one of the driest on record, with the result that, for two months, fires were raging almost constantly, and there was no time during this period when fire-fighting was not in progress at some place along the line. And in many cases the prompt arrival and efficient operation of this apparatus prevented the loss of hundreds of heavy losses, not only to the railroad company but to individuals.

In very few cases were these fires started by the locomotives, on which very efficient spark-arresters are used. In most cases the fires originated hundreds of yards, and in some even several miles, from the railroad, so that the car and its crew serves as a general fire department for the territory traversed by the railroad.

CREW IN ACTION ON FIRE FIGHTING CAR, DULUTH, SOUTH SHORE & ATLANTIC RAILWAY

The Present and Future Problems of the Railroads

As They Appear to the Director General

Walker D. Hines, Director General of Railroads in an address delivered in New York on January 7, 1920, reviewed with considerable detail the complex railroad problem, and while there was not much that was either new or noteworthy in his lengthened review of the situation, it is interesting, coming as it does from such a source. Of course it cannot be looked upon as an unbiased array of facts, and naturally so, because Mr. Hines has done all that he could to retain the railroads in the control of the government for some undetermined period, very likely until he saw fit to change his mind. With absolute control in regard to rates as well as increases in costs, there is no satisfactory explanation as to why the railroads face a deficit of half a billion dollars. It may be true as he claims that the rates were not varied soon enough, but the loss of more than sixty millions last November, and about forty millions in December is hardly excusable in the face of a long period of trial. It is as well, however, to let Mr. Hines speak for himself, and the following are extracts from the more salient points of his address:

"Before the war a joint Congressional Committee, known as the Newlands Committee, was appointed to study the difficulties, but before it reported the war conditions came and federal control began. There was widespread pessimism as to the railroad situation. Expenses were increasing and it seemed impossible to obtain increases in rates to reflect the increases in expenses. While there was much criticism of individuals in public authority, I wish to emphasize that it is my opinion that it was the system which was at fault and not the public authorities who administered the system. I do not believe any set of men could have been put in public office who could have made the system a success. I do not believe we will ever obtain an effective solution without removing the fundamental difficulties which I have suggested. First, I believe that there will not be a prompt and liberal treatment of rate questions until profits clearly in excess of a fair return are appropriated in part to the public interest.

"I do not believe that there can be successful regulation of the railroad industry without a basis for mutual understanding between those representing the public, labor, and the owners respectively. In the past there has been no basis for understanding except at the end of dispute and controversy. Each of the three great interests has worked to a large extent entirely aloof from the other two.

"Yet the railroad enterprise is a great common enterprise. It cannot be conducted without the exercise of the most vital public franchises; nor can it be conducted without the participation of a large body of skilled labor which makes a life career out of railroad employment; nor can it be conducted without the physical property which has been created by the investment of capital. We make a grave mistake in assuming that the representatives of capital can alone manage the situation. The scheme of the past has been on that false theory, and the result has been that the public has injected itself into the management through all sorts of agencies, and labor has injected itself into the management through its own organization, not only through direct demands upon railroad companies but through demands on Congress and on state legislatures and public commissions for legislation and regulations affecting management. We have all three interests participating in the management in all sorts of ways, and yet there is no common ground on which these three elements can meet and exchange views and endeavor to reach conclusions. I believe the only sort of management which can be permanently effective is one which provides for an orderly participation at the outset of all three of these interests instead of the past scheme which leaves each interest to pursue its own methods irrespective of the others until an eventual contact is established in some form of controversy looking to a solution.

"The fact is that in the past these two essential elements of the public and of labor have asserted their participation only through some form of controversy. The public side of it is asserted through hearings by legislative bodies or by commissions and these hearings nearly always take on a controversial aspect; and the result is that the railroad business is largely conducted through a series of lawsuits. The labor side of the matter generally manifests itself in an even more controversial spirit.

"I do not believe that any form of railroad operation can permanently succeed in this country when conducted through so many different railroad managements as at present. The public interest involved is almost completely homogeneous because from one end of the country to the other the public wants adequate service and a complete interchange of equipment in order to obtain that service; and, of course, enjoys uniform rates regardless of the railroad on which the traffic is carried. The labor interest involved was largely homogeneous before the war, and is almost completely so at present. We cannot therefore hope to suceed with a heterogeneous lot of railroad managements, over 100 in number, with perhaps at least 50 of a dominant character. These numerous managements will constantly embarrass each other in many ways. The great variations of prosperity and adversity will completely baffle people trying to understand the real facts as to the needs of the railroads. I believe that it will be essential to consolidate the railroads through some compulsory process into a few great corporations upon the managements of which the public and labor will be adequately represented. I know the argument is urged that this will be difficult to accomplish, but I have not the slightest doubt that it can be accomplished if the public realizes the necessity for it, and I am convinced that it is an absolutely necessary step if government ownership is to be permanently avoided.

"I am also aware that the suggestion has been made that these consolidations should come about gradually by voluntary action, but my observation of the unsatisfactory results of the old scheme of public regulation and private management are that this situation will not wait for a gradual process of voluntary consolidation. I believe that either this matter must be dealt with in a comprehensive and effective compulsory way, or that any scheme of legislation adopted will prove itself a disappointment and a failure long before voluntary consolidations can be worked out.

"On one point I believe there must be agreement, and that is that any rate increase which will at all establish an adequate credit for the various railroad companies operating independently on their own responsibility must be substantially greater than a rate increase which would protect the situation temporarily if unified control were continued until more stable conditions appear. This means that the public must pay a very substantial price in an additional increase in rates for the privilege of the immediate resumption of private management.

"When I appeared before the Senate committee on interstate commerce, last February, I pointed out the difficulties in the way of a transfer back to private management during the period of readjustment and expressed the opinion that the public would be better served, and with less cost, and railroad investors would be better protected, to continue the present federal operation long enough to tide over the readjustment period and also to admit of legislation with greater deliberation after the beginning of the next presidential term. The Congress, however, has from the time of the first proposal of this plan appeared to be adverse to any procedure other than the adoption at the earliest possible moment of general legislation and the turning back of the railroads to private management under such legislation. Since it would be out of the question for federal control to be successful without the support of Congress, the necessary steps have been taken in accordance with the sentiment and purpose of Congress for the turning back of the railroads on March 1.

In this connection let me say that despite the widespread fashion of criticizing federal control of railroads and attributing to it practically every condition that grew out of the war, my deliberate judgment is that federal control has rendered some very important public services which far outweigh any defects with which it may be chargeable. For one thing, it protected railroad credit through a period of most critical financial difficulty. When we consider, on the one hand, the precarious situation of public utilities in many parts of the country; and, on the other hand, the results which the railroad properties have enjoyed during federal control, it must be clear that a highly important service has been rendered in the protection of investment in railroad property and of the due returns therefrom."

It is worthy of note that there is an important difference of opinion in the Senate and the Lower House of Congress. The Senate desires to continue the rates, fares and charges, and divisions of joint rates, in force at the time of the repeal of the federal control act, in effect "until changed by competent authority"; while the House bill continues them in force and effect until changed by State or Federal authorities respectively, or pursuant to authority of law. Doubtless a concurrent decision will be reached soon.

Screw Threads and Screw Thread Equipment

By J. F. Springer

Varieties of Screw Threads—I.

The present instalment of a series of articles deals particularly with certain principal varieties of screw threads. The thread cutter will need to be up on the details in order to understand how to form the cutting tools.

A screw thread is defined by the outline made by passing a plane through the axis. That is, the form and dimensions of an axial section defines the thread. Fig. 1 is an example of such a defining section. The bottom of a groove is the part of the groove nearest the axis; and the top of a thread is furthest away from the axis. A thread may be viewed as a helical ridge winding about a cylinder. There are threads, however, which consist of a ridge winding about a conical surface. The Briggs thread used in the United States on pipes is spiral and not helical. That is, the Briggs thread is cut on a taper. One complete turn of a thread is a convolution. The beginning and end of a convolution are in one axial plane. It will be noted that as the thread winds about the cylinder or cone it advances or retreats along the direction of the axis. Thus, suppose we drop perpendiculars from the top of the thread onto the axis, as in Fig. 2. In the particular case illustrated, whether the thread is right-handed or left-handed, if one follows the winding from the left of the diagram towards the right, one half-turn carries perpendicular P_1 to the perpendicular P_2, and another half-turn brings it to perpendicular P_3. One may reverse the direction in which the thread is followed. The perpendicular P_3, whether the thread be right-handed or left-handed, will now in one half-turn be at P_2, and in a second half-turn at P_1. The distance that the perpendicular from the topmost point—or any other point—in a thread advances or retreats along the axis in one convolution is the lead of the thread. Note particularly here that the lead is measured along the axis. It may be measured along any other line that is parallel to the axis. Thus, in Fig. 2, the lead is AC and is measured on the axis. But the head of the perpendicular moves precisely the same distance on the line FG. That is, the distance DE is equal to the lead. Or, one may define the lead thus: Conceive the external or internal screw threat to fit without play in or on a companion internal or external thread. Then, turning the thread exactly one complete rotation and restraining the companions thread from any movement at all, the lead will be the distance the bolt or the nut has moved over the nut or bolt in an axial direction. In the case of single threads, the lead is the same as the pitch. But this mode of defining the pitch applies to single, helical threads and not to spiral (taper) threads, nor to multiple threads whether helical or spiral. It is very necessary that the matter of pitch be understood.

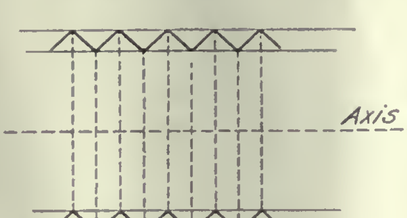


FIG. 1.

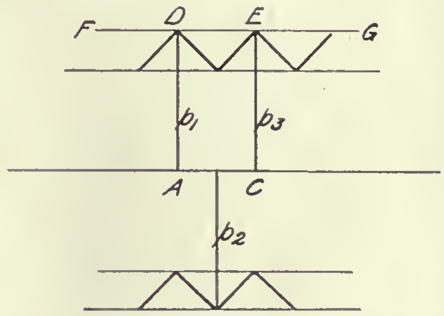
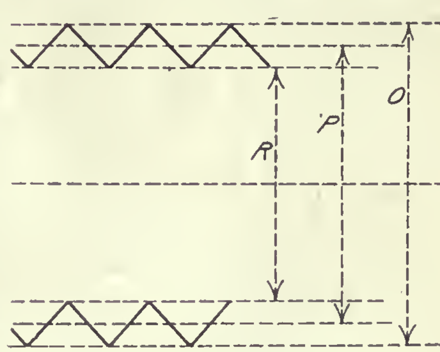


FIG. 2.

The diameter of a helical thread is the diameter of a hollow cylinder which will just envelop it. The diameter of the cylinder on which the thread is wrapped is the root diameter. The thread diameter just defined as the diameter of the enveloping cylinder may be termed the outside diameter, when it is desired to distinguish it from the root diameter or any other diameter. In an axial section of a thread, if one draws the two lines which may be drawn, on each side of the axis, to connect the bottoms of the groove, then the distant part of these parallel lines will be the root diameter. There is one other principal diameter. There is the pitch diameter, and it is the average between the other two. Thus, if the outside diameter is 5/8 inch and the root diameter is 1/2 inch, then the pitch diameter is found by adding 5/8 and 1/2 and dividing the sum by 2. The result will be 9/16 inch. Or, one may proceed thus. On one side of the axis, half-way between the two lines along the tops and bottoms, draw a third line parallel to both. Then, on the other side of the axis, draw another half-way line between the line of tops and the line of bottoms. The distance apart of the two half-way lines is the pitch diameter. See, in illustration of the foregoing, Fig. 3.

The depth of a helical thread is the distance between the two parallel lines, on one side of the axis, which lie along the bottoms and tops. The depth, it is advisable to notice, is measured perpendicularly to the axis. It is just as well for one to rivet securely in his mind the fact that both depth and pitch are measured in relation to the axis—depth, on a line perpendicular to it; pitch, on the axis itself or a parallel.

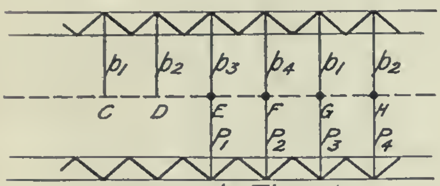
Screws are made to secure and retain a hold. The bearing on the one co-acting thread upon the other is principally upon the sides of the contacting threads. The extreme tops of the two threads have but little or nothing to do with the strength of the hold. In fact, the extreme top is frequently cut off purposely. There is thus a vacant space which may act as a marginal space permitting a trifle of inaccuracy, or imperfection. Thus, if the top of a bolt thread is cut off, it will not matter if the bottom of the groove in the nut is a trifle rounded. It is probably more customary today than ever before to cut off the top of the thread in order to promote co-action between corresponding threads. So, then, it is the sides of threads as distinguished from the extreme tips that are to be given extreme and particular attention by the machinist who wishes to be up with modern progress. If two sharp screw threads that are to co-act are known to be right at all other points, it is quite permissible, generally (but not always) to take off something from the tops of the two threads. If this is to be done, it is better done before the two are threaded together. Otherwise, the one may damage the other.



O=Outside diameter
P=Pitch diameter
R=Root diameter
FIG. 3.

Multiple Threads.

Sometimes, in order to secure special results, more than one thread is cut upon and in the same convex and concave surfaces, respectively. We now have pitch and lead to distinguish. If there is but a single thread on and in the two surfaces, pitch and lead are precisely the same. But if there are two or more threads, the lead is still the distance along the axis that the foot of a perpendicular from the top—or any other point—of the thread moves in one complete turn. In other words, it is the distance into or out of a nut the bolt will move in one rotation. The pitch is measured along the axis, too. It is the distance from the foot of one perpendicular to the foot of the similar



Quadruple Thread
FIG. 4.

perpendicular belonging to an adjacent thread. Suppose we have an axial section and that we draw perpendiculars from the tops of every one of the plurality of threads. Then the distance apart of consecutive perpendiculars will be the pitch. Consider Fig. 4. This is an axial section of, say, a quadruple thread. The lead of each is the same as the lead of all the others; and is, besides, the lead of the quadruple thread. The perpendicular P_1 is dropped from the top of one of the threads. When one traces this thread through one-half a turn, the perpendicular will have the position P_1. When the full turn is completed, the position will be the same as that of P_3. At the half-turn, the perpendicular is opposite P_3, the perpendicular of the 2nd thread ahead; and at the full-turn, the perpendicular reappears as if it were the 4th thread ahead. The pitch is any one of the equal distances CD, DE, EF, etc. The lead is the distance CG.

A bolt or nut with a multiple thread may be very rapidly shifted the one past the other. There is just as much metal involved in the grip in one case as in the other. But we are not to assume, by any means, that the tendencies to twist out of the nut are the same. The multiple-threaded bolt-and-nut tend to turn on each other when they are moderately pressed together (along the axis) or moderately pulled apart (along the axis). Unless some distinct word to the contrary is said, a thread is understood to be single.

The Simple V Thread.

The simple V thread is a proper thread to start with in explaining varieties of thread. An axial section shows a series of V-shaped grooves with A-shaped ridges between grooves. The popular angle is 60°. When such a threat is cut on a bolt or in a bolt-nut—the line of tops and the line of bottoms will convert the thread and groove into equilateral triangles, all equal to one another. The base and sides of each triangle are all equal. Now the base is the pitch. Denote it by *p*. See Fig. 5. Also, denote the depth of the thread by *d*. Since ABC is a right triangle, and since the hypothenuse = *p*, and the base = ½*p*, we have

$$p^2 = (\tfrac{1}{2}p)^2 + d^2$$

This gives $$d^2 = \frac{3p^2}{4}$$

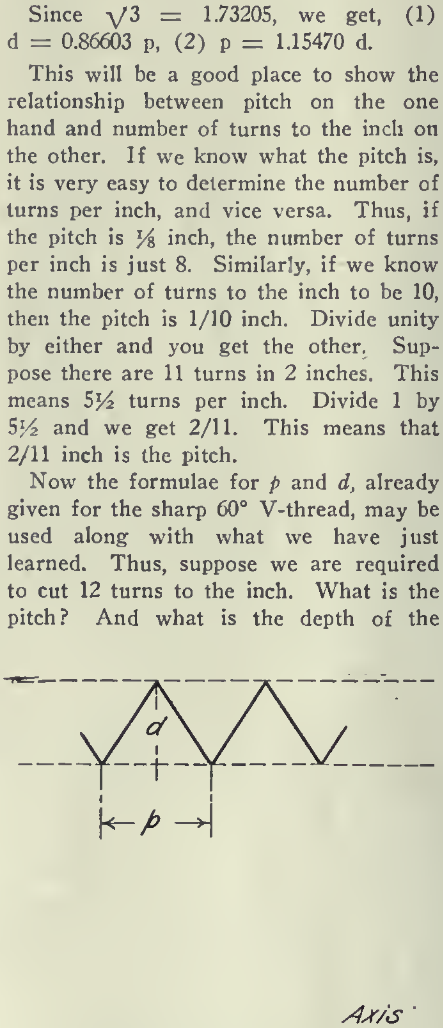
So that, $$d = \frac{p}{2}\sqrt{3}$$

And, $$p = \frac{2}{3} d\sqrt{3}$$

Since $\sqrt{3}$ = 1.73205, we get, (1) d = 0.86603 p, (2) p = 1.15470 d.

This will be a good place to show the relationship between pitch on the one hand and number of turns to the inch on the other. If we know what the pitch is, it is very easy to determine the number of turns per inch, and vice versa. Thus, if the pitch is ⅛ inch, the number of turns per inch is just 8. Similarly, if we know the number of turns to the inch to be 10, then the pitch is 1/10 inch. Divide unity by either and you get the other. Suppose there are 11 turns in 2 inches. This means 5½ turns per inch. Divide 1 by 5½ and we get 2/11. This means that 2/11 inch is the pitch.

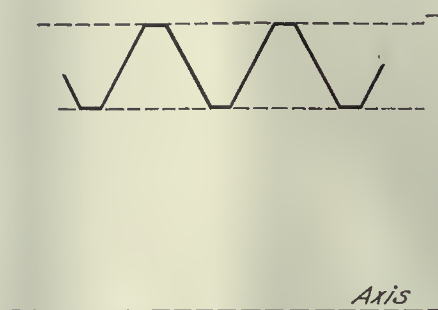
Now the formulae for *p* and *d*, already given for the sharp 60° V-thread, may be used along with what we have just learned. Thus, suppose we are required to cut 12 turns to the inch. What is the pitch? And what is the depth of the



Sharp – 60°–V–Thread
FIG. 5.

thread? With 12 turns to the inch, the pitch comes out ½ inch. That is, 0.08333 inch. With p = 0.08333 inch, the formula (1) enables us to write:

d = 0.86603 × 0.8333 = 0.07217 inch. This is how deep the tool must cut into the blank to produce the thread. The sharp V-thread has, naturally, a sharp top; and the groove has, just as naturally, a sharp bottom. The one may be flattened and the other rounded; and this will generally be a wise thing to do. But not always. If the co-acting threads are to be used to make a tight joint to prevent leakage of steam, compressed air, gas, oil, etc., then the flattening and rounding may become quite a disadvantage. Along the tops of the two threads, between them and the rounded bottoms, may be a more or less continuous path for the gas or liquid. Accordingly, it may seem best, under such circumstances, to



United States Standard Thread
FIG. 6.

leave the top of the thread and the bottom of the groove sharp, the object being to get a tight fit—or as tight as possibble. If the sharp V-thread is to be used in ordinary mechanical work and not to make a tight joint, then it will be well to flatten the top. The groove may or may not be rounded. If the sharp V-thread is to be used to make a tight joint, then the sharp tip and the sharp bottom are to be left above.

The United States Standard Thread.

This thread is a modification of the 60°-V-thread. The top of the thread is flattened to a definite level and the bottom of the groove is also made flat, the cut being halted before the sharp bottom of the V is reached. The U. S. Standard Thread may be defined as the 60°-V-thread with the two flattenings made so that ⅛ of the total depth is the depth of the top cut off and ⅛ of the total depth is the depth of the metal left in at the bottom. Consequently, the depth of the bottom Standard thread is reduced ¼ of the depth of the V-thread. See Fig. 6.

Instead, then of *d* = 0.86603*p*, as in the case of the sharp 60°-V-thread, we now have d = 0.86603p — ¼ (0.86603p). This gives: d = 0.64952p. Dividing both sides of the equation by 0.64952, we get (4) p = 1.53960d.

These formulæ apply strictly to the U. S. Standard thread and to that alone.

An example illustrative of the use of one of them is the following:

Suppose the number of turns per inch to be 6½; it is required to determine the pitch and depth. The pitch is readily determined by dividing 1 by 6½. This gives us 2/13, which is equal to 0.15385. Knowing, now as we do, the value of p, we may use formulæ (3) for the purpose of ascertaining the depth. We thus get, $d = 0.64952 \times 0.15385 = 0.9993$ inch.

Or the problem might have been reversed, and the demand might have read as follows: If the depth of a U. S. Standard thread is 0.9993 inch, what is the number of turns per inch? The first thing is to get the pitch. Formulæ (4) is the one to use: $p = 1.53960 \times 0.9993 = 0.15385$ inch. The number of turns per inch is found by dividing 1 by this result: $1 \div 0.15385 = 6.5$ (nearly) turns. We conclude then that there are 6½ turns per inch. When measuring a U. S. Standard thread that has been cut on a bolt, the foregoing formulæ may serve as useful checks to determine whether it has been cut correctly—or, in case of a worn thread brought into the repair shop, whether the wear has gone too far to correct. Thus, one may readily use the ordinary micrometer caliper to determine the outside diameter. The flat top lends itself to such measurement. The root diameter may be gotten by using a small round rod whose diameter is known with a very high degree of accuracy. This is placed in the groove and the total thickness of bolt and rod then measured by means of the same caliper as before. From this reading thus obtained, the diameter of the rod is subtracted. This gives the outside diameter less the depth of the thread. Subtract this result from the reading obtained for the full outside diameter. The difference will be the value of d. The value of p is readily gotten by counting the number of threads in 1 inch and dividing the number into 1. One expects, ordinarily, that the number of threads per inch will be a whole number or a whole number and a simple fraction like ½ or 1/3. Thus, one expects the number of threads to be 5, 6, 7, 8, or the like; or else, 5½, 5 1/3, 6½, 6 1/3, or the like. The best way to count turns will often be to select a pretty long stretch, say 3 inches or even more. Count the total number of turns and divide by 3 or whatever the total length of the stretch of thread is in inches. The object in taking a long stretch is to minimize any error in matching the end of a turn with the marks on the graduated rule.

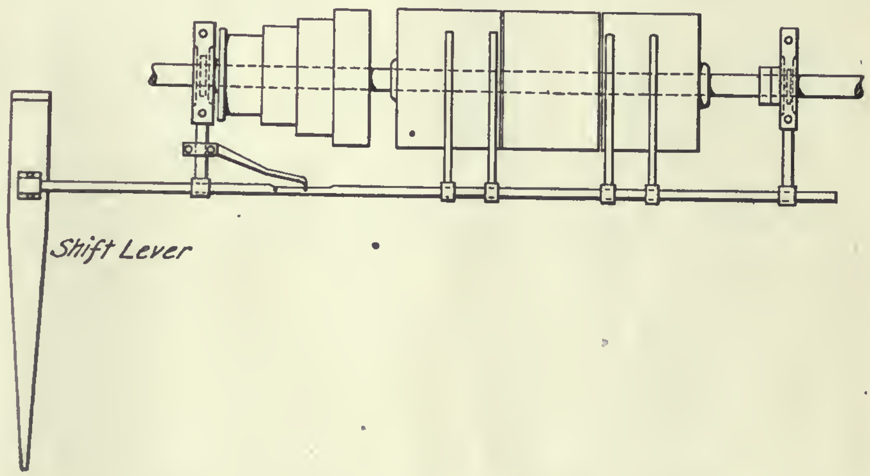
This is the first of a series of articles in which it is proposed to open the subject of screw threads, in so far as it concerns railroad repair shops. The practice of forming threads, both external and internal, will receive detailed attention. The tools used in practical cutting will be dealt with and their uses explained. Such tools as the modern ones used on engine lathes, tap dies, hand driving and power driving thread cutting machines, grinding. Hardening and tempering will also be dealt with—in short all that pertains to threads and thread cutting.

(To be continued.)

Automatically Held Belt Shifter, and Double Socket Wrench

By W. C. Clark, Pittsburgh, Pa.

As is well known, machines frequently start of their own volition, thereby spoiling work, and sometimes causing accidents. In the device shown in the accompanying illustration it will be observed that there is a space cut in the rod on which the forks are fastened. The length of the space is equal to, or a trifle greater, than the distance the rod moves in shifting the belt from the tight to the loose pulley. Notches are filed at the end of this cut out position, and also in the center if desired, depending, of course, on the type of pulley used—reversing or two speeds one way, as the case may be. The arm is fastened to a bracket which supports the pulley and there is enough spring in it that the point engages the notch when so placed, thereby preventing the machine from starting unexpectedly.

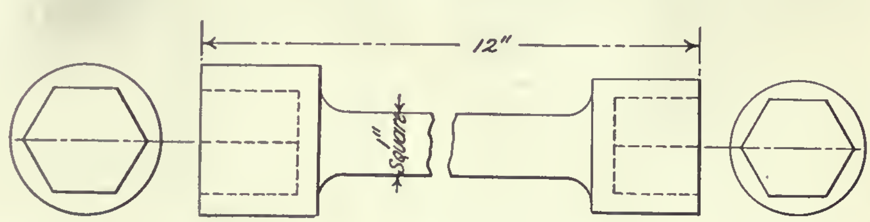


DETAILS OF AUTOMATICALLY HELD BELT SHIFTER.

The second reproduced print shows a double socket wrench which is just twice as useful as the single ended ones and more so. The center portion is forged square in order to be adapted for turning by the use of a wrench. The main feature is the making use of a liner about 1/16 in. in thickness, and hexagon in shape and capable of being readily inserted in the end of the socket and fitting the full depth of the same, and the wrench is then adapted for the next smaller single nut.

For the most common use it is well to make the large end to suit a nut the second size larger than that adapted for the small end. For example the 1 in. nut in the small end would be arranged for 1¼ in. nut in the large end. Thus by making two thin hexagonal shaped liners which can be easily inserted in the wrench, we have a socket wrench that can be used for 1¼ in. nut without using a liner, and 1⅛ in. nut when using the liner on the large end; while on the small end a 1 in. nut without liner would be suitable for a ⅞ in nut when using liner.

Any similar combination can be worked out, but it is best to skip a size between the different sized ends; for instance, for 1 in., and the other for 1⅛ in. nut, and if a liner was put in in the 1⅛ in. end, it would make a 1 in. size end, the same as the other end is already. However when two sizes are constantly in use, the wrench can be made as desired, but in any case a handy two-ended wrench may be readily made in his way which is better than a single-ended wrench, and also the added advantage by which it is made with a smaller sized wrench.



DETAILS OF DOUGLE SOCKET WRENCH.

The tool so constructed is in popular favor in some of the shops of this sec tion already, and is easily forged and durable.

New Railways in Foreign Countries

Unusual Opportunities for American Equipment

The revival of railroad construction and equipment, which has been suspended during the war, has already made considerable progress, and a rapid continuation of the work is assured. This is particularly true of foreign countries. In both the Near East and the Far East railways and extensions are planned which, in the aggregate, involve the expenditure of many hundreds of millions of dollars. There is a comprehensive programme for the construction of railways in Africa which will take fifteen years to complete at a cost of about $800,000,000. The reconstruction of railways in Europe which were destroyed by the war, notably in Poland, Roumania, and Russia, will call for other hundreds of millions. Then there are the new international lines, such as the Cape to Cairo, Paris to Constantinople, and Paris to Bucharest. All these countries offer a fruitful field for the introduction of American railway supplies. It must be borne in mind that as a result of the war American railway equipment is being used in many foreign countries that were formerly supplied by European manufacturers. Even India has recently been buying railway material in the United States.

Africa.

A French committee for the development of African railroads has recently approved a programme for the construction of 18,000 miles of track during the next fifteen years. It is proposed first to extend a certain number of existing lines in Algiers and Tunis toward the highland, and to build railway connections in Morocco. The next step proposed is to connect northern Africa with the southern coast on the one hand, and with equatorial Africa on the other. This will be accomplished by a Trans-Saharien road reaching the Niger at Bourem and Lake Chad via Nguiqni-Massenya. Routes are also on foot on the African west coast which will facilitate communication with South America. These will touch the Cape to Cairo railway, and the Belgian Congo. These lines will be connected with branch lines, particularly in the French territory of the African west coast and in central Africa. The mileage projected for the former is 7,000, and for the latter 6,000 miles.

Argentina.

With one-third the area of Brazil, Argentina has 22,000 miles of railway in operation, while Brazil has about 16,000 miles. The absence of the coastal mountain barrier, which had made railroad construction so difficult in other South American republics, has greatly facilitated the rapid development of railroads in Argentina. The war period hindered construction, but among the extensions which are planned for the near future are the Formosa-Embarcacion system, which will exploit the little-developed territories of Chaco and Formosa, and which will be about 437 miles long. In the province of Entre Rios, 219 miles will be added, about 106 miles of which have been completed.

The plans for the Patagonian State railways call for about 1,243 miles of track, 580 of which are now open for traffic, either full or provisional. When finished, this system will consist of two lines, the San Antonio and the Comodoro Rivadavia, across Patagonia from east to west, and a third extending from Puerto Deseado in the territory of Santa Cruz northwest across the Comodoro Rivadavia to the western terminus of the Port San Antonio Railway.

The Central Argentine, the Southern, and the Buenos Aires Pacific normally require the largest amounts of rolling stock. These three companies maintain extensive shops in the Argentine where they not only do repair work but manufacture a considerable amount of rolling stock.

Australia.

Arrangements are completed to carry on many railroad enterprises which have been temporarily arrested in Australia. First is an important group of five lines, each of which will open up large areas of lands suitable for settlement. The Prime Minister stated recently that Britain and Europe were not at present in a position to quote on contracts, so that the logical place for the contracts is in the United States. The necessity of immediately procuring quotations from America cannot be too strongly impressed upon the engineering houses who have representatives in Australia, so that they will be ready when bids are called for.

Bolivia.

A marked activity is going on in railway construction in Bolivia. Over 400 miles are under construction, 480 miles have been surveyed, and over 1,200 miles are projected. These embrace four different lines, and a contract has been signed recently in Bolivia for the construction of a railway from the existing system of Yungas to Coroico and thence to the Beul river, and construction is already proceeding on the Potosi to the Sucre railway.

Brazil.

We have presented elsewhere in the present issue a statement of the conditions of the prospects of railway development in Brazil, based on the most recent report of the Director of Communications, to which it may be added that from the latest reports in the Brazilian press the government is disposed to renew railway concessions upon the promise of the interested parties to import immediately large quantities of railway materials and supplies.

Chile.

Extensive new lines, and additions to existing lines have been projected in Chile, and the inspector of railways has finished an inspection of the transandine railway in company with various technical experts. This report to the government asserts that in his opinion $2,500,000 are needed for improving the lines on the Chilean side.

China.

The Minister of Communications has sanctioned the proposal and the necessary funds will be raised by the various Chambers of Commerce for extensive additions to the Chinese railways, guaranteeing the construction of an east and west transcontinental system, with branches in the northwest of China, where connections will be made with through lines to Europe through Russia and Mesopotamia, thereby tapping Central Asia, a country of great possibilities, equal in area to the United States.

"Far Eastern Markets for Railway Materials, Equipment and Supplies," by Trade Commissioner Frank Rhea, published by the United States Bureau of Foreign and Domestic Commerce, gives a detailed account of the possibilities for the sale of American railway materials in China, Japan, Korea and the Philippines.

Mexico.

Vast railway enterprises are being discussed in Mexico. Among others, an extension across the difficult Sierra Madre country, which it is estimated will cost about $15,000,000. The chief project, however, is the completion of the Southern Pacific railroad of Mexico so as to constitute a direct connection between the vast system of that company and its connecting roads in the states with the entire west coast of Mexico, including the states of Sonora, Sinaloa, Nayarit, Jalisco and across the Sierra Madre by existing lines to Mexico City. This line was completed from Nogales to Compostela, a point a few miles south of the city of Tepic, before the revolution, and freight and passenger trains were run regularly to the city named. The surveys of the road were directed to San Marcos, in the northwestern portion of the State of Jalisco, which was a temporary terminus of the line that had been built westward from the city of Guadalajara to connect with the line being built southward from Nogales. While the intervening distance is only a few miles, comparatively speaking, the character of the country is so rugged and difficult that a number of tunnels and much heavy grading are necessary, one tunnel in particular being planned that is two or three miles in length.

An American company has asked for permission to construct a line of railway extending from Matamoras directly south to Tampico. It will be in the nature of an extension to the Gulf Coast lines, which at present have their terminus at Brownsville, and will traverse the section watered by the Soto de la Marina river and bordering on the Gulf of Mexico. This region has great natural wealth, but it has never been developed because of lack of transportation facilities. Large deposits of petroleum are known to exist in the same locality, which it is the purpose of the railway promoters to develop.

Near East.

Before the war certain projects had been undertaken to improve the means of communication and transportation in the Turkish Empire and to reclaim what was once the most fertile land in the world. To correct the defects of the Bagdad railway, which was built by the Germans on strategic lines, to serve their military purposes, a branch line was built to Angora and was to be extended to Kaisariye, while others were proposed to Marash and to Urfa along the line that connects Killiz with Nisibin. Here is an arc of green extending from Aleppo to Mosul and reaching to the foot of the Armenian hills which can be made as productive as it was before anarchy banished cultivation from the land. The railroad and security will help to bring it back.

Roumania.

Roumania, with a population of 7,500,000 before the war, was the richest of the Balkan countries. Enlarged by the inclusion of great areas formerly attached to Austria and Russia, but inhabited by Roumanians, she will be potentially one of the powerful nations of Europe. There is little doubt in the minds of most observers that with direct water communication with the United States via the Bosporus to the port of Constanza she will be a large buyer in the United States. Of 2.000 locomotives in Roumania before the war, the Germans took all but fifteen. Six hundred must be purchased shortly.

Russia.

In a report dated March 20, 1919, it was stated that lack of fuel for locomotives and lack of factories for repairing them were responsible to a considerable extent for the run-down condition of Russian railways. At the beginning of 1917 the length of the Russian railways was 54,000 versts (42,000 miles)—when the government of Kerensky fell (November, 1917), the length of railways in operation had been reduced by nineteen per cent. The length of railways in operation and the usable locomotives and cars further decreased under the Bolshevik regime. In October, 1917, the length of railways was 52,000 versts (34,000 miles), the number of locomotives in working order, 15,000, and the number of cars, 520,000; in October, 1918, the length of railways in operation was 22,000 versts (15,000 miles), the number of locomotives in working order was 5,000, and the number of cars, 227,000. These latter figures refer only to those portions of Russia under the control of Bolsheviks. At the end of 1918 only 4,500 locomotives were in working order and of these 1,500 are expected to become unfit for use during the current year.

There are many reasons for the present deplorable state of the Russian railways. The principal ones are the lack of food, fuel and iron, and added to these is the disorganization in the administration of the railways. The Supreme Council of National Economy is supposed to control all railway questions, and the Commission of Ways and Communications to conduct actual operations; but, in fact, the railways are run practically by the railroad men and the railway unions, which have men of small calibre with great authority. These organizations, as well as private individuals, have too much to say on questions of railway management. There is no co-ordination between the central and provincial authorities. There is no central administration, no efficient utilization of usable rolling stock, and no practical distribution system. On some small branch lines with small junctions forty per cent of the locomotives remain idle and great numbers of cars with supplies that are most essential for the economic life of the starving country are side-tracked by local agents. These cars, sometimes unknown to the higher officials, often remain side-tracked for six months, and this condition continues.

Economical Locomotive Operation

After pointing out very clearly that many of the older class of locomotive engineers have not undergone any special examination for many years, and that during that period many improvements have been made on the modern locomotive, necessitating a review of the knowledge obtained by the engineer of these devices, T. J. Bartnett, road foreman of engines on the Delaware, Lackawanna & Western, referred to many of these changes at a meeting of the Central Railway Club, at Buffalo, held on November 13. Mr. Bartnett admitted that the great body of the locomotive engineers were doing their work admirably, but insisted that too much pains could not be taken in that continuous spirit of alertness necessary in running a locomotive.

In the course of his address he stated that the closest relations should exist between engineer and fireman while operating the locomotive on the road. The engineer should handle the locomotive with a view of economy in fuel and lubrication, etc., at all times, using the shortest possible cut-off conducive to getting his train over the road and maintaining the schedule. The grade line of the railroad should govern the cut-off to a great extent and our present power reversing devices make it possible for the engineer to change the cut-off wherever and whenever he desires with very little exertion on his part. When necessary to close the throttle, when running at high speed, it should be done gradually and left open sufficiently to permit a proper amount of steam to reach the cylinders to form a cushion between the piston and cylinder heads. This will avoid extra strains on the reciprocating parts and will also prevent carbonizing of valve and cylinder lubricants. The fireman should keep his fire in such a condition as to hold the maximum boiler pressure and also to regulate the fire, to avoid the unseating of safety valves when engine is shut off, when it is known that such shut-off is to be made, which is not always known.

It is also encouraging to the fireman when he observes that the engine is being worked economically and is an incentive to him to perform his duties in the same manner. The fireman who observes careless manipulation of the throttle, reverse lever, injector and unnecessary slipping of locomotive, is very apt to handle the firing in the same way. The engineer should also coach the fireman in a friendly manner on mechanical matters, whenever the opportunity is afforded, such as when laying in sidings waiting for superior trains or at any convenient time when the engine is not in operation. A little explanation given verbally from experience in this manner would be of material benefit to a fireman-student who is spending his spare time studying mechanical books and papers.

Great care should be taken in feeding the required amount of oil to valves and cylinders and avoid over-feeding, as it has been demonstrated by tests that too much oil creates carbon in valves and cylinders, which results in wear and breaking of valve and packing rings. It is also essential to operating drifting valves when engine is shut off to prevent carbonization.

The water level in the boiler, while the locomotive is in operation is a very important factor in the successful operation of the super-heater, while in service, as it has been shown by pyrometer tests that a high water level lessens the degree of super-heat, and causes damage to the super-heater header, units, and cylinder heads, causing them to leak, destroys lubrication and necessitates the locomotive being held out of service for repairs.

It has been observed that engineers of late years are depending entirely on the water-glass for indicating the water level in the boiler, which is a very bad practice. While the water-glass has been applied as an extra factor for reading the water level, the gauge cocks are what should be depended upon to guide the engineer in this respect, and when the cocks are tried care should be taken to know that the dripper pipe is not plugged up, thus holding water in it, and when the cock is opened, steam coming in contact with it, would mislead the engineer in thinking he had water and giving a false indication. When the cocks are tried, they should be closed gently to avoid cutting the seat and also see that they are closed sufficiently, as a slow leak would eventually cut the seat.

It has been found good practice in testing for blows with piston valve for valve and cylinder packing blows, to place the engine on top or bottom quarter and place reverse lever on center, thus covering the ports, having the brake applied. In this position, open the throttle, and if blow is stopped it denotes the trouble is covered; then move reverse lever forward or backward, opening admission ports to cylinder, and if the blow now occurs, we know it is defective cylinder packing on that side. The valves can be tested in the same manner, except that the blow will go out by the stack in many cases instead of cylinder cocks, and there are times when the blow will not show when ports are covered, but by moving the valve backward or forward, when the steam strikes admission ring, the blow will develop and we very often find a defetcive ring or valve bushing hollowed out.

Another method is to place the locomotive on the right back, lower eighth; set the air brake and place reverse lever in a position so that steam will enter left cylinder. If no blow exists, it is reasonable to believe that the left valve and cylinder packing is free from leakage. Then move reverse lever so that ports are covered on the left side and test right side in same manner. If blow now exists we know that the leak is on the right side. To indicate whether the valve or cylinder packing is at fault, take a stick of soft wood, about a foot or 18 inches long and insert it between the teeth, putting the other end against the valve chamber. If steam is passing by the valve chamber to cylinder, it will cause a pulsation, indicating that the blow is in the valve. If no pulsation is found by this method, place the end of the stick against the cylinder, which will determine without a doubt where the blow exists.

The engineer should be familiar with the power reverse gear on the locomotive and should be able to report in an intelligent manner any defects that come under his observation, so that repairs can be made. The principal defect of the power reverse gear is creeping, causing engine to change the cut-off, which means increased fuel consumption. Two principal causes for creeping are, air leaks around piston rod packing and worn pins in the gear. If caused by the air leak, the engineer can remedy it. If by worn pins, he should be able to report which pins are worn, so that the defect can be remedied at the terminal. Engine oil should be used in filling cups on cylinder and steam chests at least once each trip. In case there is a blow from the exhaust, try one or two cupsfull of signal oil, then work the gear rapidly forward and back. The piston rod packing should be set up tight, to avoid any blow at this point, as it may cause the gear to float back and forth. The air gauge should be looked at before moving the engine; if pump has been shut off, see that full reservoir pressure has been regained before opening throttle.

In reporting defective electric headlights at a terminal, the engineer should report any irregularities with the headlight equipment that he discovers while the engine is in motion on the road, as this may be of such a nature that it could not be discovered by the inspector while the engine is at rest. This might be caused by a loose wire or loose lamp in the socket; by a partly broken wire; by the armature dragging on the pole pieces of the generator or partly obstructed strainer at the governor of the generator. Any of these defects might cause a headlight failure, when the engine was in motion, but would test out O. K. when engine was standing. A partly closed steam pipe should be discovered by reduced speed of the generator; the proper speed of generator should be maintained at all times, this to protect the generator as well as the lamp from being damaged. In order to get the desired results from the headlight, it is necessary at all times that the headlight should be properly focused. You may have sufficient volume of light, but with the headlight improperly focused, the light will be of but very little value to the engineer in the way of seeing obstructions on the track. The headlight should be adjusted by the adjustment provided in the back of the reflector, so as to draw the rays of light together and strike the track the proper distance ahead of the engine to get the best results. Lamps of the recommended candlepower, recommended by the railroad operating the locomotives, should be maintained at all times and no change of the candle-power of lamps be permitted without permission of the proper officer of the railroad.

It is the practice in the past with some engineers to use the high power candle lamp in cab lights; this puts an extra load on the generator and if run under these conditions for any great length of time, will cause damage to the generator and result in failure, and it is very good practice to follow the instructions furnished by the manufacturers of the headlight equipment. In the event that the generator stops on the road, the governor should be tapped lightly, and if this does not start it, take off the cap and note whether the piston is stuck.

In many instances, the enginehouse mechanics have put in more time in locating a defect, than the time required to correct it, whereas, if the proper report had been made by the engineers, the extra time and expense would be eliminated and would also expedite the turning of power at the terminals.

During the past 20 years concessions have been granted the enginemen which relieve them of many responsibilities. How many railroads have provided by increased inspection to offset the valuable service which the enginemen rendered to the railroads? Very few railroads have protected themselves against the loss of this valuable inspection. In order to bring out the views of the members of the various railroads, the following questions would be useful:

1. To insure good locomotive performance, what is your routine of inspection, other than that provided by engineer and engine-house forces?

2. How often do you examine cylinder packing?

3. Do you recommend a short cut-off and full throttle, or vice versa on superheat locomotives?

4. Do you make monthly tests of superheater units?

5. What is your opinion of lubricating valves and cylinders; do you feed oil to cylinders or should it all go to the valves on superheated locomotives?

This short series of questions could be much enlarged, but the enlargement may safely be left to the practical men in charge of the mechanical departments, looking to the requirements and necessary economical improvements of the service generally, and locomotive service particularly.

Electric Trucks, Tractors and Cranes in Railroad Service

Their Utility and Resulting Economy

In these days when the world is echoing with a call to the working man and women to exert themselves more fully in order to make up for the wastage of war, it will also be noticed that there is a vociferous echo of acclamation on the arrival of princes and lords whose ancestors, it will be admitted, brought on wars. We have no desire to protest against either one or the other of these outbursts. We would rather assume the humble attitude of the innocent bystander and listen to the still, small voice of a truly great man, Thomas A. Edison, who recently said, "It is my belief that the world's most immediate scientific need is inventions that will lighten the grinding toil of labor." The wisdom of this weighty utterance was emphasized by several speakers at a recent meeting of the New York Railroad Club, among others by Frederick B. Fink, who pointed out that with the present labor shortage, high wages and shorter hours, it becomes necessary for railroad officials to investigate ways and means of handling freight materials in their shops and other matter at a less cost and in shorter time than is accomplished at present by the manual labor method. By the adoption of electric trucks and motors, man power is not entirely done away with, but their usage will displace from six to ten men for each machine installed, depending upon conditions and the service of those men can be employed in more profitable ways.

By the use of electric trucks and tractors, it not only means a great saving in point of cost and time, but it makes the lot of the operator a more contented one, for who would not be more contented at the end of the day after riding on a truck, as compared to the old method of pushing a hand truck, and those last few trips are very long ones after walking all day. Labor saving machines have been the working man's greatest benefit, for the machine that will conserve the strength of human beings and lessen toil, are labor saving machines.

The use of electric trucks hauling baggage and mail in passenger terminals is a common one, but its importance can hardly be enlarged upon, and while it is an established fact that the savings shown by the use of these trucks are from 58 to 80 per cent over the old method of pulling the trucks by hand, there are some items which must be taken into consideration and on which it is an impossibility to place a value in money and those are the relief to terminal congestion, and the prompt dispatch of trains resulting from the avoidance of baggage detention. This also applies to express and mail haulage, the prompt arrival of which is equally important, and these classes of material are or should be handled by electric trucks.

The electric truck, particularly the elevating platform type and the crane truck, or a combination of the two types are of such value in the shops and storehouses that the saving is almost unbelievable, as the records submitted on 51 electric trucks in 14 shops show a saving in labor as high as 89 per cent and that without the later types of trucks designed for use in shops and storehouses.

Records show that with the installation of one truck in the shops on one of the large eastern railroads, it displaced four men, who were receiving 39 cents per hour, which equals $3,744.00 per year.

On the same railroad, in the shops located in another city, 3 trucks were installed, which displaced 11 men, who were receiving 42 cents per hour, which equals $11,088.00 per year.

In the shop of another well known eastern road, an electric truck was installed for handling car seats to and from the upholstery department to the cars. This truck showed a saving of $3,024.00 per year, and that at the time when the labor the truck displaced was receiving but 24 cents per hour.

The shops of a road in the east, have in service four load carrying trucks and one tractor and these have displaced 25 men with hand trucks, 8 horses or mules with drivers and the services of a switch engine for 2 hours per day, and shows a saving over the former method of handling of $34,363 00 per year.

The electric crane truck of 2,000 lbs. capacity will be found to be a valuable unit in shops for the handling of pumps to and from the locomotive, as well as in the handling of heavy castings, etc., picking the material up, placing it on the platform of the truck, carrying it to its destination quickly and depositing it where wanted, saving a great deal of time and labor.

Equally interesting and instructive were the lessons conveyed in a paper submitted by Zenas W. Carter, in which he regretted that up to the present time mechanical handling has not been applied to the operation at freight terminals as it has been applied in the industrial field. It is possible that through the use of electrically operated conveyors of both the overhead trolley and the belt and apron and gravity types, and automatic elevators, and electric trucks and trolleys to effect great savings. The release of the great spaces now used for yards and switch storage tracks and freight stations would be of incalculable benefit. In addition the psychological effect upon groups of men operating under sanitary and healthful conditions in all kinds of weather, and with a minimum of physical effort, is certain to be such as to change their very attitude toward this work, while the synchronization of the whole would automatically speed up the productivity of each worker. What is still more important it would tend to give both regularity of hours of toil and continuity of employment, with a resultant uplift in the mental calibre of the men employed which would be immeasurable.

To prove that electricity is going to help in solving the coming problem of the railroad executives and managers and employes of the railroads in the United States, all the railroads in Cincinnati, Ohio, have made arrangements with a private operating company for the installation of a patented system of terminal operation. This company has almost completed all the installation of the electrically operated machinery necessary to carry out their method of handling freight at Cincinnati, and it is a well founded opinion that this or a similar system is going to revolutionize the transfer point interchange all over the United States.

The handling of freight interchange at Cincinnati will be as follows: The cars are spotted alongside the freight station in the usual manner. Doors are opened and hand trucks or electric trucks receive the goods in the usual manner. They are then conveyed to the uniform containers and packed into the container identically as you pack a freight car. These containers are placed in rows in the freight station, each container being plainly marked for one of the seven railroads entering Cincinnati. The containers are wood and steel boxes, 17½ feet long, 8 feet wide, 7 feet high, and are usually loaded not to exceed four tons. The containers each have wide side doors and wide end doors so they may be easily loaded with miscellaneous freight of all kinds. Also each container (at least most of them) is fitted with large substantial casters so that it may be rolled across the station floor or rolled along the platform alongside a car. When the container is filled or loaded it is lifted by a traveling electric crane, swung from its position and transported by the crane to the point where a motor truck chassis stands ready to receive the container as the complete body of the motor truck. Clamps are set and tightened, and the motor truck dashes off to the station of the railroad over which the goods in that particular container are routed. At some stations the traveling crane delivers the container to the motor truck sidewise and at others the delivery to the chassis is endwise. In most cases where endwise delivery is made, and in cases where crane operation is not necessary on account of the few containers per day to he handled, the containers are set on a type of skid, which is just high enough and wide enough between its supports to permit the truck chassis to be backed underneath the container, and the lifting and lowering is then done through the use of electrically driven chain hoists. Where this latter method is in use, the skids are in bays extending into the station shed.

When the truck reaches the destined station, the traveling crane immediately relieves the chassis of the container and then places a return container on the chassis, effecting a minimum of delay for the motor truck. A central dispatcher handles the operation of all of the motor trucks, insuring their operation for a maximum percentage of the day. The electric traveling crane of course carries the container with its load to the point nearest the spotted car of the connecting line and it is unloaded direct from the container into the car of the connecting line; or, if the goods in the container are for various small stations along the line, they are placed in proper cars in the usual manner, remaining in the container until cars are spotted for that particular freight division on which the station is located. It is entirely practicable to haul the containers about by means of a winch or an electric tractor truck, although they are not yet equipped for movement by electric tractor.

Of course, it is but a step from the development of this system into an electrically operated unit for the complete system of freight service, including delivery and receipt of freight from store door, which will be a very simple step ahead—involving merely the use of the same type of trucks and containers for the door to door service as is now employed in the inter-railroad service. It is almost necessary for similar plans to be put into use throughout the country in order to meet the demands of the economic situation of costs, manual service need and equipment shortage.

Because of this, engineers and railroad operatives are making exhaustive studies of these different machines and their coordination into handling systems. With its adoption will also come a fuller appreciation by the railroads of the value of all types of mechanical handling machinery. In our manufacturing plants, men are given the benefit of every conceivable type of machine or device which will save physical effort and conserve time and energy, or speed up production, but little use has been made of these electrically operated machines in freight and general material handling.

Endless instances of the use of mechanical handling machines could be given, where savings have resulted sufficient to pay for equipment in one or two months after installation. There are some of those records right here in the city of New York at the New York Central and the Pennsylvania Railroads, also an instance at Pittsburgh is an installation costing only $36,000 for electric trucks, which effected a saving of $18,000 per month. It is logical to believe that the very first moves on the part of the actual owners of the railroads after they have been returned to their rightful owners,

HEAVIEST TYPE LOCOMOTIVE CARRIED OVER ANOTHER LOCOMOTIVE BY THE USE OF A POWERFUL SHOP TRAVELING CRANE.

and reasonable rates of transportation allowed, will be to adopt plans and purchase and install electric auto-mechanical machinery of many kinds.

As an illustration of the extent in power to which the use of cranes in lifting heavy material has been carried, the accompanying reproduced photograph of one of the heaviest types of modern high-powered locomotives being carried over the top of another locomotive by the use of a shop travelling crane affords an excellent example of what is being done in some of the largest locomotive repair shops. Quite recently it was not an uncommon sight to see the larger half of the shop force engaged in pushing a locomotive on to the transverse table and pushing it back again into some stall convenient to the needed repairs. The fact that such appliances are being rapidly installed is the best proof not only of their utility but of the resulting economy which is the essential feature. In point of safety there has no accident of any kind come to our notice in regard to the use of such powerful appliances. There was considerable danger under the older methods, and it is one of the merits of the constructors' work in the present century that the element of safety is so fully and completely met in all their complex calculations.

Motor Driven Blowers for Ventilation

Methods of Control and Selection

The subject of ventilation is paid particular attention to in the design of buildings. It has been recognized that for human health, comfort and efficiency there should be plenty of pure air. The increased size of office buildings, schools, theaters, hotels, factories, etc., has made it impossible to rely on the ventilation secured by open doors and windows. The development of electrical apparatus has given the architects and engineers the means for producing any results they may desire.

Direct-current motors offer several advantages over alternating current motors for some ventilating applications, and occasionally it is desirable to use direct-current motors, even if alternating current is supplied by the central station. The two chief characteristics of direct-current motors that make this type especially suitable for ventilating service are: (1), they can be obtained with very low speeds; and, (2), their speed can be varied over a wide range and with as many steps as desired. Slow speed is desirable, as the speeds of most fans and blowers are low, and hence slow-speed motors can be directly connected to them, an advantage, on account of compactness, reliability, efficiency, and quietness.

Many ventilating applications require speed control. The volume of air handled must be varied with varying conditions, such as temperature, amount of smoke, etc. There are three methods by which the speed of properly designed motors can be varied. They are:

1. *Field Control.*—In this method the normal speed of the motor is the lowest speed, and speed variation is obtained by increasing this speed. We know that the speed of a motor depends on its field strength, the weaker the field, the faster the speed. If the field is weakned, then, in this motor under discussion, the speed will increase. Now the field can be weakened in either one of two ways—by cutting out some of the turns of the field (taps would have to be brought out to do this), thereby having fewer ampere turns, and thus a weaker field, or by connecting steps of resistances in parallel with the field and shunting away some of the current from the field, which weakens the field and gives increased speed.

2. *Armature Control.*—In this method the normal armature speed is a maximum and variations lower the speed. The speed variation is obtained by cutting resistance step by step into the armature circuit.

3. *Combined Field and Armature Control.*—In this method the two above methods are combined. There is a wide speed range with the normal speed in the middle and it can be increased or decreased.

Which of these three methods should be selected depends on circumstances. The general rule can be laid down that a motor operates most efficiently at its normal speed, so that if a fan or blower must operate at a low speed, which is only occasionally increased, method No. 1 should be used. Method No. 2 is used where the speed is high and a reduction of speed is desired occasionally. Where a very wide speed range is essential and operations may take place at long intervals at any step, then method No. 3 will be best.

The power required to drive fans and blowers can be closely estimated. The size of the motor required to drive a centrifugal fan can be estimated from the following formula:

$$HP = \frac{5.2 \times Q \times WG}{33{,}000 \times E}$$

Where—

HP = Horsepower of motor,
Q = Cubic feet of air per minute,
WG = Pressure of air in inches by water gauge,
E = Efficiency of fan (expressed as a decimal),

E for several types of fan is as follows:

Steel plate	0.50
Sirocco	0.65
Cone type	0.45

The following mathematical relations are theoretically true for all centrifugal fans and can be used in calculations

Volume varies as the speed.

Pressure varies as the square of the speed.

Hosepower varies as the cube of the speed.

Hence if a fan, when running at 100 r. p. m., delivers 8,000 cubic feet of air at ½-ounce pressure and requires two horsepower, at 200 r. p. m., it will deliver 16,000 cubic feet of air at 2-ounces' pressure and will require 16 horsepower.

Reduction of the inlet or discharge area will reduce the power required if the speed remains constant, and if the area is increased the amount of power will be increased.

Disc Fans develop low pressure and it is customary to figure their output on a basis of velocity rather than pressure. The above relations between volume, pressure and horsepower also hold for this type.

If the outlet is restricted the power and the pressure will both increase until, with an entirely closed discharge, about twice as much power is required as with an unrestricted outlet, with the same type of fan.

Westinghouse-Ventura fans have sufficient power to operate safely with 60 per cent. reduction in outlet, which is a factor of safety to take care of abnormal conditions, such as a heavy wind pressure against the fan.

Positive Pressure Blowers and Exhausters.—Five horsepower is allowed by the manufacturers of positive blowers for every 1,000 cubic feet of air exhausted per minute against a pressure of 16 ounces per square inch.

Any reduction in the outlet will greatly increase the power required. When operated with a totally closed outlet, the blower may be wrecked or the motor burned out.

In closing it might be added that it is well to secure the opinion of a consulting engineer before settling on the particular equipment in order to meet the exact requirements of the situation. It will be found that a careful survey by engineers of wide experience pays in the end, and it should not be expected that a good mechanic is also a competent designer.

Details of Parts of the Pacific Type Locomotive as Shown in Our New Chart, No. 12

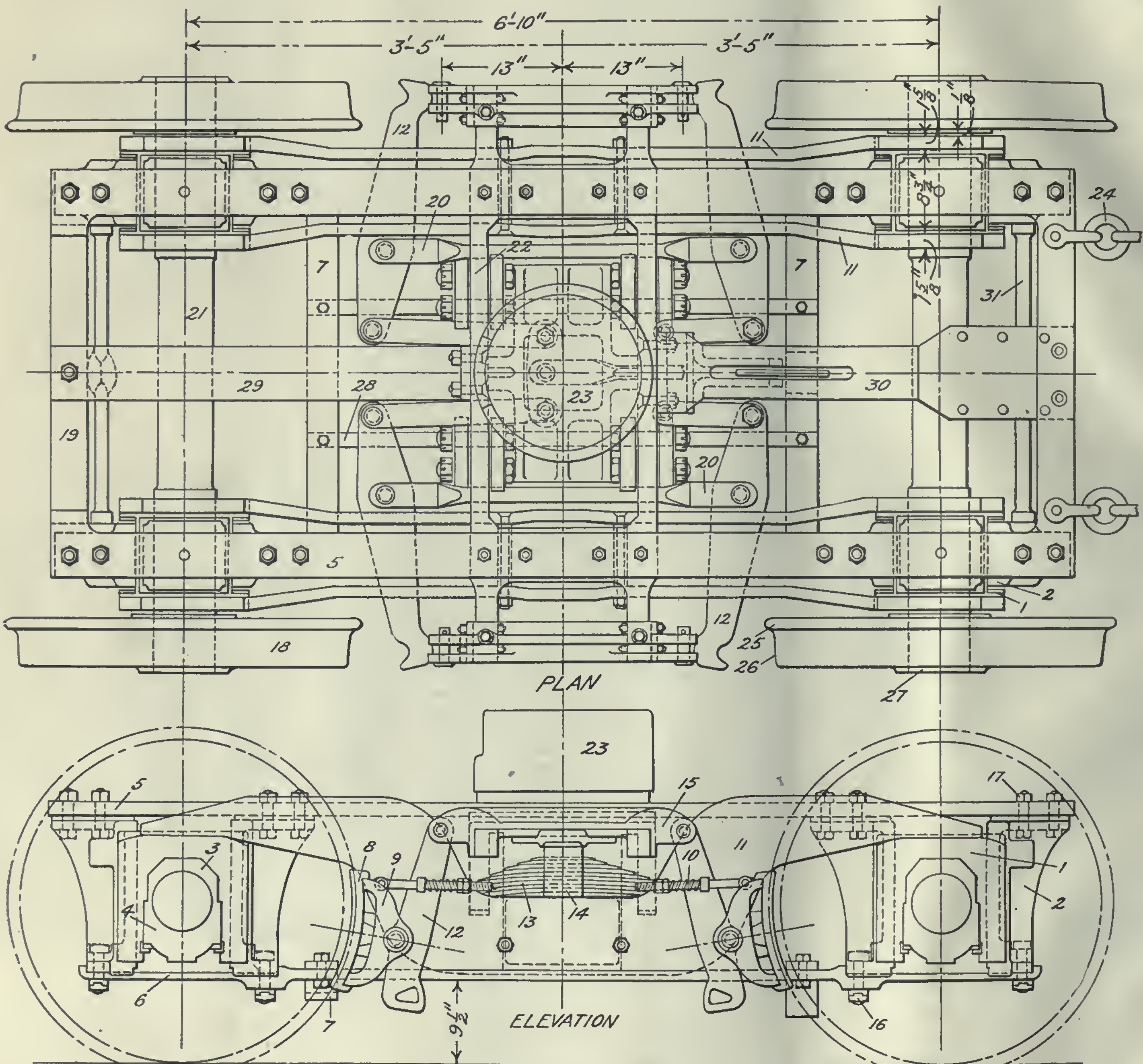
The Front Truck.

The front truck used upon the Pacific Locomotive Chart is, of course, of the four-wheeled type, and owing to the weight to be carried and the speeds at which such engines must be run, it is of an exceedingly strong and rigid construction.

The main frame is forged solid. The transom (22) is a steel casting bolted to the side frame at each end with the center plate dropping down between the two cross-pieces and braced on each side by the transom bases (29 and 30). The pedestals are of cast steel bolted to the side frame and held by castle nuts, which also holds for the transom and its braces. The legs of the pedestals are braced by the cross-ties (31) which run from the bottom of one pedestal leg up to the frame on the other side, thus not only forming an X bracing for the pedestals, but also triangulating the bracing, and so securing the maximum rigidity. The bottom of the pedestal legs are tied together on each side by the usual pedestal tie, which are in turn fastened together by the cross ties (7).

The journal boxes are of close-grained cast iron and have the usual half hexagonal boxes pressed in with the cellar below. The axles have 6½ in. by 12 in. journals. The wheels are of solid rolled steel and are set with a wheel base of 6 ft. 10 in.

The load is carried by two equalizers on each side, which have the usual bearings on the axle boxes, and which themselves carry the semi-elliptic springs upon which the truck rests.



DETAILS OF PARTS OF FRONT TRUCK OF PACIFIC TYPE LOCOMOTIVE.

The brake rigging is interfulcrumed and there are no brakebeams. The brake heads are carried on the brake levers and are balanced by their adjusting springs. There is a main lever which is guided in the slot in the transom brace (30) and which is fulcrumed on a bracket dropping down from the transom. The lower end is coupled by means of an equalizer and links to the inner ends of one set of the levers (12). The outer ends of these levers hook into the lower ends of the vertical levers (12), which are fulcrumed at their upper ends, and as their lower ends are carried towards the wheels, the brakeshoes are applied. The connection between the two sets of horizontal brake levers (12) is made by the brake lever connection (20), which works under compression.

At the end of the truck there are the safety chains (24) to prevent the truck from slewing across the track in case of a derailment.

Names of Parts as Numbered on the Illustration.

1 Truck journal box.
2 Truck pedestal.
3 Journal brass.
4 Journal box cellar.
5 Truck frame.
6 Pedestal tie bar.
7 Pedestal tie bar crosstie.
8 Brakeshoe.
9 Brakehead.
10 Brakehead adjusting spring.
11 Truck equalizer.
12 Brake lever.
13 Truck equalizer spring.
14 Spring band.
15. Brake lever fulcrum.
16 Pedestal tie bar bolts.
17 Pedestal bolts.
18 Truck wheel.
19 Truck end piece.
20 Brake lever coupling bar.
21 Truck axle.
22 Truck transom.
23 Truck center plate.
24 Truck safety chain.
25 Wheel flange.
26 Wheel tread.
27 Wheel nut.
28 Pedestal tie bar crosstie stay.
29 Transom and end piece brace.
30 Transom and end piece brace and brake lever girdle.
31 Pedestal cross brace.

These numbers do not occur on the chart No. 12, and are appended at this time as supplementary in order that the details of the truck may be distinctly known to those interested in obtaining the full and complete information.

These supplementary numbers will be continued in describing other details from month to month, and the careful student will know not to confound them with the numbers shown on the chart which refer to the par shown and numbered on the chart, and it would be well to retain the detailed descriptions so that the parts fully described may form a convenient commutary which it would not be possible to attach to the chart itself.

Strengthening Rail Joints by Heat Treatment.

An interesting contribution to the discussion as to how to strengthen steel rails is that of a Pennsylvania Railroad experience to the effect that plain angle bars, if heat-treated, can make a rail-joint having strength and efficiency equal to that of the solid rail. Heat-treatment, it is stated, produces an increase in elastic limit ranging from 60 per cent in solid 100-pound rails, to 79 and 150 per cent in plain angle-bar joints with six and four bolt-holes respectively. In the rail the elastic limit was raised from 175,000 to 280,000 pounds, while in the bars it was raised from 70,000 and 50,000 pounds to 125,000 pounds in both cases. From this the conclusion is drawn that heat treatment was one of the simplest and most economical means of increasing the efficiency of the joint. The treatment mentioned consisted in heating the material above the recalescence point (about 1,500 degrees Fahrenheit), quenching in water, and then annealing the hardened steel at about 1,050 degrees Fah. The report also points out that a joint equal in efficiency to the solid rail can be obtained by heat treatment of some of the patented types of rail joints, or at less cost by a similar treatment of a special angle bar. The joint with this bar showed a strength at the elastic limit equal to that of the rail, and would cost less than the standard angle bar which had a strength of about 33 per cent that of the rail. The new bar was to be used with heat-treated fish bolts, as being shorter than the standard bar it might require greater bolt strength. Comparison of joints having four and six bolts respectively indicated that the two additional bolts gave no increase in strength in transverse loading. It was concluded that a four-hole fishplate is sufficient for a 100-pound rail if it is of proper section and material. As to fishplates 26½ inches and 18½ inches long, tests with 20-inch and 26-inch spacing of sleepers indicated no loss of efficiency in the point with the shorter fishplates.

Heat Treatment of Side Rods.

There has recently been a marked advance in the methods of heat-treating parts incidental to locomotive and car construction and maintenance. In making forgings requires a carbon content of from rate of heat advancement and the capacity of the hammer used are of great importance. After forging, the parts are first thoroughly annealed to relieve the strain set up in forging. They are then heated and quenched in oil or water. From there they are placed in the drawing-back furnace where they are tempered. The steel used in making these forging requires a carbon content of from .40 to .55 per cent. The quenching and drawing-back temperatures are governed by the per cent of carbon contained in the steel. The physical requirements of the heat-treated forgings are determined by the specified diameter or thickness which governs the size of the prolongation from which the test specimen is secured. It should be taken at a point midway between the centre and outside of the forging in the direction in which the metal is most drawn out. All forgings should be given a thorough annealing to relieve the strains set up during the forging operations to insure good treatment.

Swedish Railway Tests of Disk and Ball Bearings.

A. Danielson, a civil engineer of considerable prominence, has been advancing the claims of the disk bearing before the Swedish Technological Society of Stockholm. He has proved that the initial friction in a ball bearing is only a fraction of the initial friction in an old-fashioned gliding bearing, and that a machine provided with ball bearings is consequently handled much more easily. Besides, there is, he said, a considerable saving of power or energy, especially if the load, speed, and oiling cannot be kept uniform. He claimed, however, that disk bearings are a happy combination of the ball bearing and the roller bearing, that the load capacity of the disk bearing is about 50 per cent greater than that of the ball bearing, and that the disks, by always rotating around the same geometrical axis, will gradually be worn into a form most favorable with reference to friction. It was also claimed that the disk bearings are stronger and more suitable for heavy loads than the ball bearings, and that when used for railroad cars they bring the following economical advantages: Less expense for upkeep, because the disk bearings for cars which are not constantly used in express traffic will last, without adjustment, for a year, instead of half a year; decrease of stoppages on account of heated bearings; saving of oil, and saving of power.

The results of the experiments will be awaited with interest by the engineering world, and further details may be expected to be forthcoming at an early date.

Train Speeds in Europe.

In Europe, the palm was usually given to the Nord Company's 7:50 a. m. train, Paris to St. Quentin, which was shown as having traveled 95.75 miles in 93 minutes, equivalent to a speed of 61.8 miles per hour, while the North Eastern Railway Company's famous 12:20 Newcastle to Sheffield, England, express covered the distance between Darlington and York (44.128 miles) at a speed of 61.57 miles per hour (Darlington, depart 1.9; York, arrive 1.52).

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Locomotive Terminal Equipment.

The formation of an association looking towards the improvement of locomotive terminal equipment is a step in the right direction. It will be generally admitted that there is a pressing need for a general rehabilitation of the railroads, and a particular need for a better equipping and rebuilding and enlarging of locomotive terminals. The records of the Railroad Administration show that the locomotives were spending nearly sixty per cent of their time in the engine houses. To this should be added the time getting in and out of terminals. As a matter of fact the locomotives are not actively employed over one-fourth of the time, and there is a present need for a rehabilitation of the equipment, and there is an equally pressing need for better facilities.

The names of the men prominently identified with the project of looking towards the best terminal facilities are a sufficient guarantee that the highest engineering skill can readily be secured through this organization, and with that encouragement which the combination deserves, there is the promise of an assurance that a vast improvement in the direction indicated by the new organization will be realized in the near future. It is not necessary at this time to point to particular cases. It is obvious to every one that while the number of locomotives and cars have increased rapidly and will continue to increase, nearly all of the terminals remain in the cramped, conjested, poorly planned condition in which their original haphazard constructors were compelled to meet in some way the pressure of circumstances in the vanished years, when capital was limited and the vision of the future needs of expanding traffic was not given to the early promoters of railroad facilities. Doubtless they did the best they could, if they did not do the best they knew, and it is for us, their successors, to take up the unfinished task and in the light of a large experience, carry on the good work.

The Railroad Question in Congress

Many of the people of the United States forget, or perhaps they do not know, that the government is a delegated government. The Reds think it should be relegated, but they are mistaken. It is the best form of government ever established on earth. It should be remembered that the people are potential only on election day. The representatives fairly chosen are then responsible, and it should not be imagined that they do not fairly reflect the will of the people. It would seem, however, that as it is so easy to find fault the clamor that surrounds the members of legislative bodies is deafening. Generally speaking, the noise goes in at the one ear and out at the other. The legislator knows that the noisiest are not the most thoughtful, and apart from the regularly organized bodies whose utterances reflect some measure of concrete opinion, the unasked correspondence of individuals is little regarded. Back of it all is the silent, thoughtful multitudes who watch the trend of events and make up their minds for next election day.

Congress is now busy on the railroad problem, and we look hopefully for a solution. The legislators are in earnest. Party lines are being little regarded, and we are confident that the result will be a fair reflex of the best thoughts of our time in regard to the encouragement and development in transportation. In the light of the war time necessity much has been learned, particularly in the advantages to be gained by the standardization of equipment, and the crying need of a more liberal policy looking towards obtaining the means to maintain the equipment. Legislation framed on the American principles of fair play will not only be a safe guarantee of the future growth of the railroads, the promoters and owners of which are entitled to the same consideration as that of any other private enterprise, but it will also show that there is no sense establishing methods of repression that will hamper enterprise or divert the fruits of ingenuity to sources other than to where they are justly due.

That transportation in America is the cheapest in the world should be a matter of congratulation and surprise, and in these days of high prices it is absurd not to expect that a considerable increase in rates is just as inevitable as in any other department of furnishing the needs incident to human existence. If there be any crying need among the people of the United States at the present time it is a little more of the fine compound of patience and common sense.

Individual Responsibility.

A writer in a recent issue of the *Atlantic Monthly* summed up a discussion of the methods of influencing public opinion with the statement that "demagoguery is a parasite that flourishes where discrimination fails, and only those who are at grips with things themselves are impervious to it." For, in the last analysis, the demagogue, whether of the Right or the Left, is, consciously or unconsciously, an undetected liar." And it is against this undetected liar that all members of the community need to be on guard at this time. We are confronted on all hands by appeals to work together in peace as we did in war, as the only means of salvation from present economic troubles and every individual agrees that that is the proper course for the community, but too frequently makes a personal or class exception and proceeds to try and get while the getting is good, as was the openly proclaimed policy of more than one class leader even while the country was in the throes of a life and death struggle. To the onlooker there seems to be little real difference, so far as profiteering is concerned whether the obnoxious process is carried on by overcharging for food or service rendered.

It has been said so often that it has become a platitude, that asserting that the quickest, best and only effective way to lower the cost of commodities is to increase production and yet that is the very thing that the leaders of those who call themselves the producers have, thus far, failed to do. As wages have increased the man-hour efficiency has fallen, sometimes to one-half what it was before the booming of cannon and prices shook the country to its foundations, and the worst of it is it started to fall even during, yes, almost at the very start of, the period of stress.

As an English contemporary expressed it: "The spirit of sacrifice for a common end appears to be falling to a very low ebb, the ideal of service becoming less recognized. The complexities in a period of transition afford unique opportunities for wrecking and some are ill advised enough to press a temporary advantage to its uttermost limit."

And those who are pressing this temporary advantage seem to think that there is no uttermost limit. But there is, and unless saner and more moderate views prevail there will be an industrial crash that will carry all with it and not excepting those who have advocated a continual increase of pay and decrease of efficiency. It is a startling comment on the attitude of those who are grasping at everything in sight, that through all this strenuous endeavor they have not urged an increase of output as at least a partial compensation to those who have to provide for that increase of pay.

It would be fruitless to ask that this be done by the mass. For, when the mass comes together, it almost invariably happens that the demagogue holds sway with his glib tongue. It is for the individual, each individual to quietly assume the responsibility of doing his part as he knows he ought to do it and thus to himself be true, knowing that, then, he cannot be false to any man.

The old saw of taking care of the pennies and the pounds will take care of themselves is apropos here. Let each individual do his own productive duty and the mass production will take care of itself.

Canadian National Railways.

Speaking on the completion of the first year in the life of the Canadian National Railways, President D. B. Hanna stated that the day of the small independent railway system had passed. In the United States, where the railway problem is very much in the public eye, the experienec gained in the two years during which the railways have been under government control has shown that certain measures which railway managements had resorted to as good business moves, but which regulating bodies had more or less recently made illegal, were really in the best interests of the country as a whole; therefore is it proposed in turning back the railways to their owners, that certain of these practices previously frowned upon, should now be encouraged. Consolidations and mergers, and the pooling of traffic, earnings, equipment and facilities are to be permitted. There is to be a greater coordination between rail and water carriers, more especially on inland waters.

Several plans put forward, by various groups, for legislation to cover the situation, provided for compulsory consolidation of the lines into great, but competing, systems. So that an accepted condition of proper transportation for a large country would appear to be large systems, but preserving competition. It should afford the people of Canada considerable satisfaction to know that the contemplated plans and generally accepted proper policy for the United States to adopt with respect to the railway problem seem to be largely along the lines of securing what the Canadian Government has taken steps to obtain. In Canada, two strong systems, serving every community in the country, will compete for the nation's business. We look forward with confidence, not to the death by exhaustion of our single, but great, competitor, but to a healthy and active rivalry, with full co-operation, should the transportation requirements of the country ever demand it. That one of the two systems is owned by the people through the government should, in my opinion, improve rather than adversely affect the situation. After a year's trial of the present plan of control of the National railway system, there has been, I am able to say, no governmental or political interference.

Molybdenum High Speed Steel.

The story of the development of high speed steel has been one of such leaps and bounds that it takes an active mind to keep up with it. At present molybdenum steel seems to be crowding to the front. At the time of the outbreak of the war an Austrian firm was making molybdenum steel for various purposes that was very successful. Each grade was made for a particular purpose and was sold only on the express stipulation that it should be used for the work for which it was made and for no other. The object of this was to insure that the steel should be raised to the temperature at which its cutting efficiency was greatest and be kept there. In fact many of the failures to obtain satisfactory results with high-speed steel have been due to attempts to use it for purposes for which it was not intended, and especially where the crucial cutting temperature was not attained and maintained.

When these conditions are maintained there is considerable evidence accumulating that better results can be obtained with molybdenum than with tungsten steel. Naturally as the molybdenum alloy is a later entrance into the high-speed field, a great deal of experimenting has been needed in order to secure a proper stabilizer. In a recent communication to *Engineering* this matter is touched upon, and the position that vanadium is an efficient stabilizer of molybdenum is disputed. As a matter of fact, not long after the introduction of tungsten high-speed steel molybdenum high-speed steel, both with and without vanadium, was made in England, France, Germany, Luxemburg, Austria and the United States. The occasional startling results of such molybdesium mixtures, superior to the very best tungsten high-speed steel, induced many firms to plunge into schemes for producing molybdenum steels on an extensive scale, but many if not all had to be abandoned because of lack of uniformity. Much of it was of excellent quality, but, on the other hand, batches of tools failed entirely when subjected to workshop tests, although they showed the correct analysis. In the cases where vanadium was added it failed to be uniform in bulk manufacture just the same as the molybdenum steel without vanadium; consequently these makers fell back upon tungsten.

Faith in vanadium as a stabilizer is attributed to the circumstance that experiments were made merely on small quantities. However, only bulk production can disclose the quality of a real stabilizing element.

Mr. P. R. Kuehnrich of Sheffield, who has the reputation of having carried out more tool steel alloying experiments than any other living man, made the discovery that cobalt acted as a definite stabilizer of molybdenum, and based on the formulae thus developed, many hundreds of tons of molybdenum super-high-speed steel have been made and distributed, apparently demonstrating beyond all peradventure that cobalt is a true stabilizer of molybdenum.

Molybdenum high-speed steel is more costly to produce than tungsten steel; but the manufactures claim that users are willing to pay the higher price, because the greater service which the material renders makes it, in fact, the cheaper. But as with other high-speed steels this greater service is dependent upon its being used as it is intended by the manufacturers.

Our New Chart.

The chart showing the details of a Pacific type locomotive, and which was finished some time ago, has met with some little delay owing to the congested state of the printers' trade, and the unusually large number of readers who have made inquiries in regard to it are assured that we are doing our best to make up for the delay, and copies will be in their hands just as soon as we can overtake our work in packing and mailing them. Every subscriber to Railway and Locomotive Engineering will be furnished with a copy of the new chart, and to those who are making inquiries in regard to the price, we would state that owing to the high price of production of this double chart, showing not only a sectional side view, but an additional view of the back or boiler head, the price is fifty cents per copy.

The fault, if it is a fault, is probably our own in not making allowance for the congested condition of the printing trade. All that we can do is to hold our spirits in patience, and we believe that our readers will do the same, and the vexatious delay will soon be among the things that are forgotten.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection
(*Continued from page* 370, *Dec.*, 1919.)

1031. Q.—What are some of the bad habits a man can get into in the manipulation of brake valve handles?

A.—Allowing the handle to remain in running position when charging a freight train; coupling to a charged passenger train with the valve handle on lap position; too long a time in release position; allowing the valve handle to stop on lap position before a service application; moving the handle from lap to running or holding position without first moving to release position; moving the handle away from running position at any time except in actual cases of brakes sticking or for applying brakes; using partial emergency position for a service stop, and constantly using the independent brake valve in release position when the automatic valve is in running position.

1032. Q.—What do you conclude from watching a man make these movements to release position with the independent valve while the automatic valve is in running position?

A.—That he knows very little about the operation of the brake valves and distributing valve.

1033. Q.—What is the object of the supplementary reservoir of the LN equipment?

A.—To provide a high emergency brake cylinder pressure, quick recharge and a graduated release.

1034. Q.—Are all of the features of the P triple valve retained in the L valve?

A.—Yes, and in addition, quick service and a safety valve arrangement that limits the service braking ratio but is cut out when the triple valve is used in quick action.

1035. Q.—What is meant by quick service?

A.—That when the triple valve assumes service application position, each triple valve makes a local brake pipe reduction, thus positively continuing the reduction throughout the brake pipe, in a similar manner that the quick action is propagated, but in a lesser degree.

1036. Q.—What difference is there in the emergency portions of the L and P triple valves?

A.—None.

1037. Q.—What difference in the triple valve pistons?

A.—None except in size.

1038. Q.—What difference in the slide valve?

A.—It is somewhat larger and contains more ports than the valve of the P triple.

1039. Q.—What difference in the graduating valve?

A.—The graduating valve of the L triple is of a slide valve type.

1040. Q.—What piston and valve are added to the L triple valve?

A.—The by pass valve and piston.

1041. Q.—What is the piston and valve used for?

A.—To operate and admit the supplementary reservoir pressure into the auxiliary reservoir and brake cylinder during an emergency or quick action application of the brake.

1042. Q.—How is the auxiliary reservoir of the LN equipment charged?

A.—From the brake pipe through a feed groove in the piston bushing in the usual way and in addition through a port leading from the check valve case through the slide valve seat and slide valve.

1043. Q.—Why is this additional port?

A.—So that a rapid charging of the reservoir can be obtained, or rather so that both the auxiliary and supplementary can be charged in about the same time required for a P triple valve to charge an auxiliary reservoir.

1044. Q.—Why is the port opening of the additional charging port made from above the check valve?

A.—So that when a brake pipe reduction is made, the check valve will prevent any flow of pressure from the auxiliary reservoir into the brake pipe except that which can flow back through the usual feed groove.

1045. Q.—How is the supplementary reservoir charged?

A. — From the auxiliary reservoir through the triple valve slide valve and seat.

1046. Q.—At what times is the supplementary reservoir connected with the auxiliary?

A.—Only when the triple valve is in release or emergency positions.

1047. Q.—After the reservoirs are charged to a pressure equal to that in the brake pipe, what parts of the equipment are open to the atmosphere?

A.—The brake cylinder through the triple valve exhaust port, the safety valve passage and the chamber in which the emergency piston operates.

1048. Q.—How can it be determined when the charging of the reservoirs is completed?

A.—The buzzing noise made by the triple valve will cease.

1049. Q.—What causes this buzzing noise?

A.—The check valve falling to its seat due to the flow of air pressure through the charging port above the check valve.

1050. Q.—How much difference in pressure between the brake pipe and auxiliary reservoir is required to lift the check valve against the tension of the check valve spring?

A.—About 4 lbs.

1051. Q.—Explain how the triple valve operates when a service brake pipe reduction is made from the locomotive brake valve?

A.—The pressure in the brake pipe being lowered at a faster rate than at which it can flow back from the auxiliary reservoir and supplementary reservoir into the brake pipe through the feed groove, the higher auxiliary reservoir pressure moves the triple valve piston.

1052. Q.—What does the first movement of the triple valve piston result in?

A.—A closing of the feed groove, absolutely separating the auxiliary reservoir and brake pipe pressure while at the same time the graduating valve which is attached to the piston opens the service port through the slide valve.

1053. Q.—What stops the movement of the piston?

A.—Its end coming in contact with the graduating sleeve, the latter being held in place by the graduating spring.

1054. Q.—What else does the piston do on this movement?

A.—The piston engages the slide valve and brings it along to application position.

1055. Q.—What is this position called?

A.—Quick service.

1056. Q.—What port openings are made?

A.—The service port is partly opened to admit auxiliary reservoir pressure to the brake cylinder and the quick service port is opened to admit brake pipe pressure from the triple valve check case to the brake cylinder.

1057. Q.—What ports are closed by the movement of the slide valve?

A.—The brake cylinder exhaust port and the port leading from the auxiliary reservoir to the supplementary reservoir.

1058. Q.—Is the brake cylinder exhaust port closed before the service and quick service ports are opened?

A.—Yes; otherwise there would be a blow or waste of air from the triple valve exhaust port as the brake started to apply.

1059. Q.—Is the pressure in the supplementary reservoir used at this time?

A.—No, it remains bottled up.

1060. Q.—What occurs if the brake pipe reduction through leakage or because of a very short train is so rapid that the auxiliary reservoir pressure cannot expand into the brake cylinder through the partly opened service port as rapidly as the brake pipe pressure is falling?

A.—The graduating spring will be partly compressed and the valve will be moved to full service position.

1061. Q.—What is the difference between full service and quick service position?

A.—In full service position the service port is opened wide and the quick service port is entirely closed.

1062. Q.—Why is the quick service port closed?

A.—Because the brake pipe reduction is then being made at such a rapid rate as to make a quick service feature unnecessary.

1063. Q.—What is the actual object of the quick service?

A.—To continue a brake pipe reduction and insure a prompt brake application throughout a long train of cars.

(To be continued)

Train Handling.

(*Continued from page* 371, *Dec.*, 1919.)

1079. Q.—What would probably be the result of a triple valve being more sensitive to respond to brake pipe leakage than the feed valve was senstive to maintain it?

A.—Quite likely a stuck brake.

1080. Q.—Why should a stuck brake result?

A.—For the reason that brake pipe pressure is usually withdrawn at a faster rate than at which it can be replaced by the feed valve, when it is not in good condition.

1081. Q.—What is required to operate a feed valve?

A.—A differential in pressure.

1082. Q.—How much difference?

A.—Enough to overcome the tension of the supply valve piston spring and frictional resistance of the parts.

1083. Q.—About how much is this difference in pounds?

A.—From 7 to 12 lbs.

1084. Q.—Could the feed valve then be expected to operate correctly if there was less than 15 lbs. excess pressure in the main reservoir?

A.—Not under all conditions.

1085. Q.—What does this signify when the excess pressure governor top is used?

A.—That the proper amount of excess pressure is maintained and that the air gages are correct.

1086. Q.—What is excess pressure?

A.—The difference between that in the main reservoir and the brake pipe.

1087. Q.—Or in other words, what is the excess pressure at 140 lbs. main reservoir and 110 lbs. brake pipe pressure?

A.—30 lbs.

1088. Q.—Is there any difference in the length of the brake pipe exhaust at the brake valve when L triple valves are used?

A.—Yes, the exhaust is much shorter for the same brake pipe volume, as a considerable amount of the brake pipe volume is used in the brake cylinders instead of escaping to the atmosphere through the brake valve.

1089. Q.—What movement occurs if the brake pipe reduction ceases after 10, 15 or 20 lbs. pressure has been withdrawn from the brake pipe?

A.—The auxiliary reservoir continuing to expand into the brake cylinder will instantly lower the auxiliary pressure below that remaining in the brake pipe and the difference in pressure will cause the triple valve piston and graduating valve to move to lap position.

1090. Q.—To which lap position, full service lap, or quick service lap?

A.—It depends upon which position the slide valve was in when the brake pipe reduction ceased.

1091. Q.—What occurs in lap position?

A.—The flow of air to the brake cylinder, either from the auxiliary reservoir or from the brake pipe, is cut off.

1092. Q.—What occurs if the brake pipe pressure is then increased sufficiently above that in the auxiliary reservoir to overcome the frictional resistance to the movement of the piston and slide valve?

A.—The triple valve piston and the slide valves will be moved to release position, opening the brake cylinder to the atmosphere for a release of the brake and the supplementary reservoir pressure will be free to flow into the auxiliary reservoir.

1093. Q.—What will this result in if the brake pipe pressure is not maintained or if the brake valve is returned to lap position immediately after the triple valves have moved to release position?

A.—The inflow of supplementary reservoir pressure will drive the triple valve piston back to what is known as graduated release lap position.

1094. Q.—What action occurs at this time?

A.—The brake cylinder exhaust port is again closed, retaining the remainder of the brake cylinder pressure that has not had time to escape, and the flow of air from the supplementary reservoir to the auxiliary reservoir is stopped.

1095. Q.—How is this movement utilized during a release of brakes?

A.—To graduate the pressure out of the brake cylinders in any amount desired.

1096. Q.—What action results if the brake pipe pressure is maintained to a figure very much over the maximum carried when the brakes are being released, or in other words, if the brake pipe pressure increases at a faster rate than at which the auxiliary reservoir pressure increases through the inflow from the supplementary reservoir?

A.—The brake releases straight away, as with previous types of triple valves and the auxiliary reservoir is recharged from the supplementary reservoir up to within a few pounds of the original pressure.

1097. Q.—What is the advantage of this quick recharge?

A.—It requires no brake pipe pressure for a recharge of reservoirs until after the brakes have had time to release, consequently there is no drain on the brake pipe that would tend to absorb brake pipe pressure and prevent a prompt release.

1098. Q.—What will be the point of equalization between supplementary and auxiliary reservoir pressure after a 20-lb. brake pipe reduction and a release?

A.—About 105 lbs.

1099. Q.—After a 30-lb. brake pipe reduction?

A.—At about 102½ lbs.

1100. Q.—How do you estimate the pressure which the reservoir will equalize at after various brake pipe reductions?

A.—On the assumption that the reservoirs are so proportioned that a 1-lb. drop in the supplementary reservoir will increase the pressure in the auxiliary reservoir 4 lbs.

1101. Q.—Is this absolutely correct for any pressure from 0 to 100 lbs.?

A.—It may not be absolutely correct, but is close enough for all practical purposes for brake pipe reductions with standard pressures carried.

1102. Q.—What advantage has the quick recharge of the auxiliary reservoir?

A.—The brake system is at all times ready for an application.

1103. Q.—What other great advantage has this type of brake?

A.—About 4 full 20-lb. service brake applications can be made without recharge and the brake will still be more efficient than the P. M. or High-Speed brake with a 110-lb. brake pipe pressure.

1104. Q.—After 4 service applications without recharge, what would the supplementary reservoir pressure be?

A.—Approximately 90 lbs.

1105. Q.—Why would the brake be more efficient at this time than the P. M. brake with 110 lbs. in the auxiliary reservoirs?

A.—Because with an emergency application the P. M. brake would develop from 80 to 88 lbs. brake cylinder pressure which would be blown down to 60 lbs. during the stop while the L. N. brake with 90 lbs. would develop about 84 lbs. brake cylinder pressure and retain this to the stop.

1106. Q.—Explain the action of the brake if the brake valve handle is placed in emergency position, or if a conductor's valve is opened or if there is any sudden drop in brake-pressure that will exceed a service rate?

A.—The triple valve piston and slide valve will be driven the full distance of their stroke by the sudden differential in pressure and the triple valve will be in what is known as emergency position.

1107. Q.—What resistance to movement must be overcome in order for the valve to assume quick action or emergency position?

A.—That of the graduating spring.

1108. Q.—What flow of air pressure occurs when the valve moves to emergency position?

A.—The brake cylinder exhaust port is first closed and the auxiliary reservoir is opened directly in to the brake cylinder, while the supplementary reservoir is opened into the auxiliary and both reservoir volumes equalize with the brake cylinder.

(*To be continued.*)

Car Brake Inspection.

(*Continued from page 372, Dec., 1919.*)

996. Q.—What might be wrong if the leak existed only when the brake was applied in emergency position?

A.—It would point to leakage from the leather seat at the large end of the emergency position.

997. Q.—How should one be governed in attempting to locate the source of these leaks?

A.—By remembering which parts control the flow of air from the various exhaust ports.

998. Q.—As an example, at what points would a leaky release slide valve cause a blow?

A.—At the application chamber exhaust port as well as the emergency piston exhaust port.

999. Q.—Where could a leaky emergency slide valve cause a blow?

A.—At both the emergency and service brake cylinder exhaust ports.

1000. Q.—At what points would the leaky equalizing slide valve cause a blow?

A.—At the reduction limiting chamber exhaust port as well as at the application chamber exhaust port.

1001. Q.—Why will a leaky exhaust valve of the application portion show a leak at the service brake cylinder exhaust port only at a time the brake is applied?

A.—Because there is no air pressure in the service brake cylinder when the brake is released.

1002. Q.—How will the leaky application valve be manifested after the brake is applied?

A.—Usually by a blow from the service cylinder exhaust port.

1003. Q.—How will this occur?

A.—Service reservoir pressure continuing to flow past the leaky valve into the brake cylinder will build the brake cylinder pressure up to a point higher than that in the application chamber and this will force the application piston toward release position far enough to open the exhaust port and discharge a like amount from the brake cylinder.

1004. Q.—How would you account for the leaky application valve if it existed when the brake was released, but did not create any leak at the service brake cylinder exhaust port when the brake is applied?

A.—It indicates that the leakage from the service brake cylinder or its connections is equal to the amount that the slide valve is leaking.

1005. Q.—How can the leaky exhaust valve be distinguished from the leaky application valve while the brake is applied?

A.—It is not necessary to distinguish the difference as the application portion would have to be removed in either event.

1006. Q.—Is the same attention to be given to cleaning and repairs that is accorded triple valves?

A.—Yes, unless there are some special instructions to the contrary.

1007. Q.—How often should the control valve be tested?

A.—In the same general way that triple valves are tested with the portable brake test truck or a similar device when a train is made up or at least once each week.

1008. Q.—If the valve is removed for cleaning and testing how should the test be made?

A.—On the standard test rack in accordance with the code of tests for the valve.

1009. Q.—What amount of increase in brake pipe pressure should affect a release of the brake when the valve is being tested in a train?

A.—An increase of 2 lbs. at a slow predetermined rate should result in a release.

1010. Q.—What change has recently been made in some of the graduated release caps?

A.—They are arranged in a fixed position with the projection or indicator of the cap pointing straight downward so that this type of cap cannot be turned to graduated release position.

1011. Q.—It will be noticed that some of the equipments have a size smaller brake cylinder for emergency operation than the one used for service, why is this?

A.—So that instead of doubling the service braking ratio, or using two cylinders of the same size, a size smaller brake cylinder reduces the emergency braking ratio to about 160 instead of 180 per cent.

1012. Q.—With 110 lbs. pressure in the brake pipe, how long should it take to charge the pressure chamber of the control valve to 105 lbs.?

A.—From 70 to 95 seconds.

1013. Q.—And the emergency reservoir to the same figure, 110 lbs. brake pipe pressure being maintained?

A.—From 45 to 65 seconds.

1014. Q.—The service reservoir, same conditions?

A.—From 55 to 75 seconds.

1015. Q.—How should the graduated release cap be set during a charging test?

A.—It must be in release position.

1016. Q.—What would be wrong if a pressure chamber charged much faster than the time indicated?

A.—It is generally caused by an enlarged feed groove or by a leaky release piston packing ring.

1017. Q.—What tests are made on a test rack in addition to the charging and leakage tests?

A.—Service sensitiveness, packing ring leakage, release tests, leakage into brake pipe test, continuous brake pipe reduction to produce emergency, sensitiveness of the application portion, time of releasing air from the application chamber, graduated release test, sensitiveness of charging valve, and service port capacity test.

1018. Q.—During the service sensitiveness test, what pressure is under the diaphragms of the differential valve?

A.—Pressure chamber pressure.

1019. Q.—And if there is a discharge from the vent port of the differential valve before the valve is moved to application position?

A.—If the lever and handles are in the correct position, it indicates excessive frictional resistance to movement.

1020. Q.—What is it necessary to do preparatory to the packing ring test?

A.—Substitute a suitable cap and cover for the bottom cap of the release piston portion and remove the pressure chamber check valve.

1021. Q.—Why remove the pressure chamber check valve?

A.—In order that leakage past both the equalizing and release piston packing rings will show on the air gage.

1022. Q.—And to test the equalizing piston packing ring alone for leakage?

A.—Replace the pressure chamber check valve and make the test.

1023. Q.—And the ring leakage in either case is shown in what manner?

A.—In lbs. per minute on the pressure chamber air gage.

1024. Q.—And this should not exceed?

A.—Three lbs. per minute past each ring.

1025. Q.—If the total ring leakage, with pressure chamber check valve removed is 5 lbs. per minute, and with the check valve in place, 3 lbs. per minute is shown past the equalizing piston ring, what is the leakage past the release piston ring?

A.—Two lbs. per minute.

(*To be continued.*)

The Groove and Arc in Arc Welding

By J. F. Springer

In welding with the electric current by means of a hand electrode of metal, it is important to have the edges of the joint in such shape that easy access is possible to all points of the two edges. A beveling of the two edges and a setting of them a trifle apart will ordinarily cover the requirements. There is no fixed angle of bevel required. An angle of 60 degrees, however, may be taken as quite suitable for the generality of cases, especially if the edges are substantially separated at the time of welding. Oxy-acetylene welders will please note the difference in bevel from what is customary in gas welding. The 60-degree slant in electric welding means a slope of 60 degrees with the horizontal. If two such bevels

LOCOMOTIVE TRUCK, LEFT SIDE BROKEN AND WELDED WITH U S L ARC WELDER WITHOUT REMOVING

are brought edge to edge, the resulting groove will have a cross-sectional angle of 60 degrees also. However, a 45-degree bevel is also considered proper in electric welding. The cross-sectional angle of the groove is then 90 degrees, naturally. Any angle is suitable that will facilitate the action of the welding. The beveling, as for oxy-acetylene welding, may be done in various ways. The cold chisel provides one means. The beveling may sometimes be very properly done by an upsetting process. Or, sometimes, the cutting ability of the gas procedure may be utilized to produce the bevel. In any case, the edges are, if necessary, to be thoroughly cleaned. If the beveling is done with a cold chisel, the edges should naturally be clean. Where other means are employed, the file, the emery wheel or emery paper, the wire brush or the cold chisel may be employed to expose fresh and clean material. All this is quite important and not to be neglected.

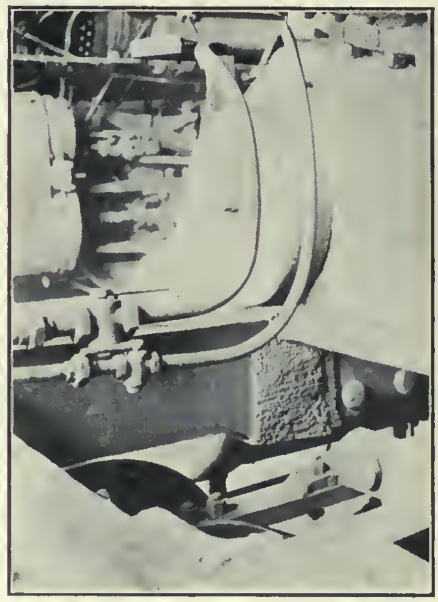
The work is arranged on a worktable and held by clamps or other holding device. Or, the two halves may be parts of a single piece of work and already in proper relative position at the edges. If possible, the operator will generally do well to make sure, before starting up the actual welding, that as little attention as possible will be required of him to maintain the work in position during the melting in of the electrode.

Before striking an arc, the welder should safeguard himself from certain activities that will then come into existence. Gloves should be used to protect the hands. These should be made of leather. There should be a shield for the protection of the eyes and face. The goggles employed by oxy-acetylene welders are inadequate for arc welding. If the eye-and-face-shield is not employed, eye soreness is apt to result and a burning of the skin. The glass used to protect the eyes should be in three layers—(1) a red glass, then (2) a blue or a green glass, and finally (3) an ordinary uncolored glass. The uncolored glass has no function in respect to softening the glare from the arc, but is used solely for the purpose of protecting the colored glasses from damage from flying bits of metal or the like. The uncolored glass is, accordingly, placed outside, next the arc.

I have already given attention to the advantage of a short arc over a long one, because of the comparative ease with which the stream of metal from the metal electrode may then be preserved by the surrounding sheath of oxide gases. The proper length for a short arc is in the neighborhood of ⅛ inch. The arc may be produced by touching the tip of the electrode against the work and then dragging the electrode slightly, holding it somewhat inclined. As the drag goes on, the electrode is withdrawn and the arc established. After the arc is once fairly in existence, the electrode is to be held at right angles to the work, or very nearly so. This appears to suit best the passage of heat from the electrode to the work and the consequent melting of the surface of the groove.

This is a very essential matter, the actual fusing of the metal on the surfaces of the groove. Just as in oxy-acetylene welding, it is necessary (if the use of the hammer or an equivalent is to be avoided) that melted metal be added to melted metal. If melted new metal be deposited on unmelted old metal, perfect cohesion is not to be expected. Similarly, when the new metal is flowing onto other new metal already in place, it is necessary that the under metal be in a molten condition as well as that which comes upon it. The operator should never let himself forget this requirement as to the molten condition of the underneath metal whether it is old or new.

It is considered important that the arc be broken as few times as possible. A good welder should seek to use up an electrode without a single break in the arc. To carry out this program; he will need to proceed without hesitation; as, a slowing up to get time to consider the



LOCOMOTIVE FRAME, RIGHT SIDE UNDER CYLINDER WELDED WITH U S L ARC WELDER

next step is likely to be fatal to the continued maintenance of the arc.

The reason that it is undesirable to permit a breakage of the arc turns largely on the fact that such breakage is apt to result in the oxidation of metal at the weld. The protective covering being removed, the highly heated metal is exposed to the exygen of the atmosphere. Oxidation spots undoubtedly tend to produce interference with cohesion.

Direct and Alternating Currents.

The arc method of welding may use either the direct or the alternating current. Advantages and disadvantages are urged on both sides. Alternating current is often, not to say generally, the type of current supplied by power houses. The system which uses alternating current at the arc naturally does not require a motor generator to effect conversion to direct current. However, some type of transformer is needed to reduce the voltage of the current as it is supplied by the power house. The problem of using the alternating current has, by one concern at least been solved to the point that a portable apparatus is found practical. This company claims that it is possible to melt 1 pound of metal with an expenditure of 1½ to 2 kilowatt-hours of current. Further, they claim rapidity of deposition of metal. This is an important factor, since it involves the cost for the workman's time. Economical melting of electrode might, with slow deposition, be more than offset by the expense for the operator. However, I do not wish to become seriously involved with the pros and cons of a discussion on the relative merits of the two types of current. The reader who becomes a possible purchaser of equipment will do well, perhaps, to request the competing manufacturers to state their several cases. There are now on the market apparatus which use alternating current. Probably, after both sides have had their full opportunity, the matter will simmer down down to a better suitability of the one or certain work and of the other for certain and to a good, workable suitability of both for still other work. It is scarcily likely that either will ultimately drive the other off the field.

Pre-heating is done by some and omitted by others. One of the large manufacturers speaks rather reservedly in respect to the advantages. "Pre-heating of medium and mild steel before applying the arc is not necessary and will only enable the operator to make a weld with a lesser volume of current. This, however, will reduce the speed of welding because the rate of depositing the electrode metal is dependent upon the current flowing." If we are to accept this as really an authoritative statement that pre-heating actually accomplishes no economic result, it is unfortunate, since it means a disadvantage upon the side of electric welding when compared with the oxy-acetylene procedure. With the gas method, a decrease in the amount of work to do means a more rapid operation or a less consumption of gas; that is, less heating to attain the desired temperature is something permissible with less gas or else the welding may be done at a more rapid rate. Off-hand, it would seem as of something similar ought to hold true with regard to electric welding. With less heating to do, there should be some modification possible so that proper advantage could be taken. However this particular matter may really be, the use of pre-heating as a means of sometimes restoring the quality of metal in or near the joint is not denied

Steel that has been overheated may often be restored by heating it up from below a medium cherry red (1274 degrees, F.) to a proper annealing point, which varies more or less with the carbon content. Roughly, the less the carbon content, the higher the annealing point. Now if a job is heated up in advance by means of a charcoal fire, an oil torch, a gas torch or some other source of heat, the heat being applied to the joint and the neighboring metal, this heat thus stored in the neighborhood may, after the joint is welded, become useful in reheating the new metal that has been deposited. "The pre-heating operation will raise the temperature of a large portion of the [iron] casting. When the weld is completed, the heat in the casting will flow into the welded section, thereby reducing the rate of cooling." But a reduction in the rate of coiling is not necessarily an annealing operation, nor does the writer of the passage quoted quite think so. Real restoration of quality is understood to require first a cooling below 1274 degrees and then a re-heating to some point above. The surrounding heat may be equal to the job of heating up the slug of metal in the weld; but has that slug cooled down below 1274 degrees? This is a question to be left to the skilled mechanic.

The foregoing analysis would seem to make it necessary, or at least advisable, somehow to cool the metal in the weld subsequently to the welding operation and before the influx of heat from the surrounding metal into the weld takes place.

However this may be, the authority mentioned seems to find pre-heating useful in connection with cast iron welds. The work is heated in advance over a generous region around the joint; the weld is made; and then the heat from the surrounding parts flows into the joint and tends to soften the film of steel which is understood to form between the slug of new metal and the sides of the groove. The reduction of the rate of cooling "will not yield as good results as actual annealing." This has been proved by repeated experiments that are trustworthy.

The Development of the Brazilian Railroads

The history of the railroads in Brazil bears a strong resemblance to the early history of railroad development in the United States, particularly after the proclamation of the Brazilian republic in 1889, when she entered feverishly into the construction of new lines. The system in many cases was not well advised. It lacked cohesion, intermittent branches beginning in some provincial districts and ending literally nowhere. It may be stated briefly that the population has not kept pace with railroad enterprise, with the result that the government has been compelled to assume responsibilities that have borne heavily upon the taxpayers. The government, to its credit, has done nobly, and never better than at the present time. From the most recent report of the Brazilian Inspector of Railroads, a summary of the work done on the roads inspected by the federal government is of interest, particularly in view of the needs of new equipment and the determination of the government to meet the necessities of the situation as they may be found.

In the report referred to the railroads of Brazil are divided into three groups:

	Kilos.
Owned by the government	15,251
Owned by private companies	10,051
Owned by state governments	2,464

In the first group there are:

	Kilos.
Under government management	6,420
Under lease-holding companies	8,850

In the second group there are, as property of railroad companies:

	Kilos.
State of Sao Paulo	3,952
State of Minas Geraes	1,880
State of Rio de Janeiro	1,515
State of Santa Catharina e Parana	1,487
State of Espirito Santo	607
State of Rio Grande do Sul	186
State of Pernambuco	154
Other states	265

Belonging to state governments, there are in the third group:

	Kilos.
State of Sao Paulo	1,826
State of Bahia	321
State of Para	316

Wishing to develop the railroad industry in Brazil, the government not only constructed or bought the railroads it owns today, but assisted several companies by guaranteeing the interest of the capital invested in the construction of the lines. During 1918 the government paid nearly four and one-half million dollars as guaranty of interest. The "Sao Paulo-Rio Grande" received $2,671,286. The "Victoria-Minas" received $1,082,269. The government's lines of the "Sorocabana" received $321,263 subsidy. The small line, with 68 kilometres in traffic on the bank of the Tocantins River received $148,399. The lines subsidized of the "Leopoldina" received $174,340. In Minas Geraes, the "Jaguara-Araguary" line of the "Mogyana" system, $133,105.

Only the lines in Sao Paulo, viz., the "Sao Paulo Railway," the "Mogyana" and the "Paulista," and a part of the 'Leopoldina," earn income enough to cover expenses and meet the interest on the capital invested in the construction. The private lines in the coffee districts, however, did prosper.

Under the presidency of Prudente de Moraes (1894-1898), the Brazilian Government initiated a policy of nationalization of the railroads. The government, by better management, desired the lines to provide from their income the interest on the capital invested in construction. These hopes were not fulfilled. It is plain today that the policy of leasing railroads to private companies was a failure, just as well and for the same reason that the policy of the guaranty of interest by the government failed to solve the railroad problem in Brazil. In undeveloped districts of small economic resources, any measure will prove a failure, because railroad traffic, rapid but expensive, is the privilege of zones rich enough to support it.

The confidence of the public in government management is increasing and the federal government operates the following lines:

2,400 kilos. Central of Brazil R. R.
1,400 kilos. Western of Minas.
1,270 kilos. North Western.
891 kilos. Ceara R. R.

No lease-holding company in Brazil manages its railroads better than does the government. Complaints arise everywhere; in Rio Grande do Sul, in Bahia, in the South of Minas, in Pernambuco; the public is clamoring against the lease-holding companies. The Rio Grande do Sul system cost the government nearly 58 million dollars. Leased to the "Compagnie Auxiliaire," it produced in 1917 only $250,467, less than ½ per cent on the capital invested. The "Thereza-Christina" R. R. to the coal mines in the valley of the Tubarao River shows a constant deficit. The Central of Brazil R. R. cost the government over 131 million dollars, and has not paid any interest on this enormous expenditure of capital. The "Leopoldina Company," with nearly 3,000 kilometres of road in the hilly districts of the States of Rio de Janeiro and Minas, has never distributed yet to its present shareholders even 5 per cent of dividends; and this in spite of being a reconstruction of original companies which saw their capital annihilated. After several years of no dividend at all, the company distributed lately from 2 to 4 per cent. The Southern of Minas R. R. cost the government nearly four and one-half million dollars and with the greatest difficulty paid the insignificant rent of $105,263. The Bahia system, with 1,900 kilometres of lines does not earn income enough to pay the expenses, and the rent amounting to $120,000 is less than ½ per cent of the investment. The "Great Western," with 1,621 kilometres of lines in the states of Pernambuco, Alagoes, Parahyba and Rio Grande do Norte, does not much better than the lines further south, the rent only representing 1 per cent of the cost. The "Sobral" and "Baturite" lines of the Ceara R. R., with 891 kilometres, cost $13,160,000, left a credit balance of a little over 2 per cent. This read, managed by the government, in a region desolated by a prolonged drought, is giving a larger income than any line outside of the coffee zones. The Madeira-Mamore R. R., serving the rubber districts of Bolivia and Matto Grosso, is subject to the unsatisfactory condition of the rubber trade. The line cost the government 15 million dollars and has little prospect of improvement in the near future.

After this clear statement, the Inspector of Railroads lays stress on the manifold difficulties besetting the railroad industry in Brazil which the government alone is able to solve. The prolonged war, the concomitant upsetting of shipping, and similar causes, have made coal, material and other requisites go up to prices never dreamed of, producing a shortage of rolling stock and an enormous increase in the ratio of the traffic expenses. These difficulties are still increasing every day, and the Inspector fears, if nothing is done to remedy this state of affairs at once, "that the Brazilian lines will be ruined through lack of repairs and the complete deterioration of the rolling stock, which cost the country such heavy sacrifices to build and organize." He shows that all lines belonging to the government, managed by it, leased out, constructed by state or federal governments, or subsidized, must today be extended into promising districts or the freight tariff raised and the rent lowered.

He advises to make a complete inventory of all rolling stock to ascertain what is required in locomotives, cars and platforms, repairs of the permanent roadbed, change the existing rails for heavier ones, where necessary, and having recourse to a financial operation to pay for all these things. With these new means a complete reconstruction of the existing lines should be made in preference to building new lines.

The federal Inspector of Railroads who made this report is Dr. Pires do Rio. He was nominated Minister of Communications, to serve in the cabinet of President Epitacio Pessoa, who assumed office last year.

Perhaps the most gratifying part of the reports that come to us in regard to the future of the Brazilian railroads, as alluded to elsewhere, is the determination on the part of the government that there shall be a substantial guarantee of funds to meet the new equipment so necessary to the rehabilitation and extension of the railroads so essential to the developments of the varied dequirements of the Republic of Brazil.

The Burning of Tubes.

Editor Railway and Locomotive Engineering:

I have been very much interested in the article on "The Burning of Tubes," page 356 of your December number, particularly as I happen to have been the Master Mechanic who was the victim in the first case. My explanation of the case, however, is rather different. In my judgment what really happened was, that this bundle of tubes formed a ready regenerator. The ends being open and a slight breeze blowing, air entered at the open end, gradually heated as it progressed and finally reached a temperature at which combustion of the iron took place. What appeared to be melted iron proved on examination to be puddle cinder. It was not the entire pile but the central part of it, possibly one hundred of the four hundred flues being burned up for a distance of three or four feet.

The second case is clearly a similar one, but the third case is not so clear, but apparently the combustion was at the front end, the natural draft being towards the front. I cannot but suspect that this was another case of the bundle of flues acting as a regenerator, preheating the air to a point where combustion followed. It is to be noted that in all cases there were masses of flues, which would tend to conserve the high temperature. I have never heard of any case of this kind with a single flue.

A funny sequel to the first case was that when I showed the destruction of the flues to the Superintendent of Motive Power, with the expectation of a vigorous call-down, the only comment after a long examination was "D——d if I would not have been fooled too." A. W. G.

Painting Ironwork.

There are many positions where girders and other iron members are used which are not prominently in view, and often because metal work is not in immediate view it gets neglected. In putting in out-of-sight work it should be all cleaned thoroughly and have one or two coats of red lead and raw linseed oil paint, usually about 4 lbs. red and 1 lb. old white lead thoroughly ground together, forming the pigment, no driers or turpentine being used. The paint is made fresh as required, and is well worked in with stiff paint brushes, each coat being allowed to dry before a succeeding one is applied. After the work of building is finished all dirt should be cleaned off the ironwork, and if the paint has been removed or broken another coat should be applied. In places where steam and moisture is prevalent all concealed ironwork should be examined and, where necessary, repainted at least once a year, but where exposed to view there is less need to specially hunt after paint defects, as they soon make themselves apparent.

Electrical Department

Third Rail—Electricity in the Manufacture of Steel

Third Rail and Its Location With Respect to the Running Rail

In the preceding article we pointed out that the electrical design of the locomotive will depend on the system of electrification, but irrespective of the internal apparatus the locomotives can be classified under two headings, namely: those equipped with pantagraph trolleys to collect the current at high voltages from overhead wires located several feet above and directly over the track, and those equipped with third rail shoes to collect the current from conductors located alongside of and adjacent to the running rails. Without going into the design and construction of the collection devices, we considered, in the preceding issue, the location of the overhead conductor in respect to structures and the rolling equipment.

In this issue we will consider the third rail and its location with respect to the running rail. A conductor placed alongside of the track at a fixed distance away from the running rail and slightly above it constitutes the third rail system.

The location of the third rail has become more or less standardized. There are two different types. The over-running or top contact third rail is so located that the third rail shoes, carried in the locomotive to collect the current, slide along on top of the third rail. The under-running or under contact rail is so located that the third rail shoes slide along on the under side. In either case the rail is supported by bracekts about every ten feet, insulators being used to insulate the rail from the brackets. To prevent accidental contact with the third rail by employees and also to eliminate trouble due to sleet and snow, a guard or covering of wood is provided.

A high grade steel is not necessary for the third rail; in fact, it is very desirable to have the rail of very low carbon steel, much lower than is used for track rails, as the low carbon steel is of lower resistance than the high carbon steel. Iron or steel has a much higher resistance than copper, and while the cross section of the rail is much greater than if copper was used, still as low a resistance as possible is desired to cut down the transmission losses to a minimum. To make the third rail continuous the sections are bonded together by copper bands.

The location of the two types of third rails in respect to the running rails is shown by Figs. 1 and 2. Referring to Fig. 1, the over-running third rail, the insulators supporting this rail rest on long ties placed at intervals of about ten feet. insulator used is a block of porcelain which sets over a short pin screwed into the tie, to keep the insulator located. On top of the insulator is placed an iron cap provided with projections to hold the rail. The rail is neither clamped or fastened, the weight of the rail being sufficient to hold itself in place. In case of derailment the rail would be pushed over, which is distinctly an advantage and it can easily be assembled again with little damage done.

The under-running third rail layout is shown by Fig. 2. The rail is supported every ten feet as in the case of the over-running rail. The method of support is not as simple, however. The rail is suspended from insulators, each consisting of two halves clamped around the rail, and these insulators are supported

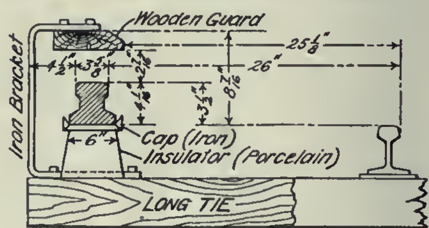


FIG. 1.

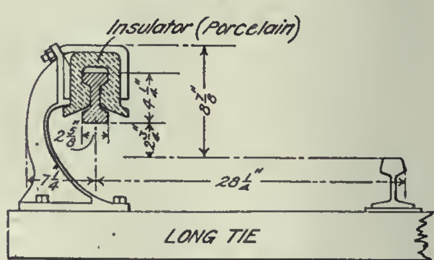


FIG. 2.

from brackets which are necessarily curved. The insulators are bolted to the brackets, and the tightening of the bolts not only holds the insulators to the brackets but clamps the insulators tightly to the third rail. Between the insulators, which are approximately 8 ins. long, are placed wooden strips around the rail except on the bottom surface, to protect the rail from being touched accidentally.

The above general description, as well as that included in the previous issue, gives us an idea as to the problem to be met in the collection of the electric current. Large electric traction systems require heavy drafts of power and many hundred kilowatts are collected from the conductors at various speeds. Third rail power is of low voltage and high current density and can be easily collected by the third rail shoes. With the alternating current systems, the voltage is high and the current low and the proper clearances and insulation is the important factor. The current can be collected as easily as from the third rail. The high voltage direct current of 3,000 volts cuts down the current demand over that of the third rail for the same power transmitted, but still a considerable current must be collected. A few special provisions makes the collection of this current an easy matter.

The Important Part Electricity Plays in the Manufacture of Steel.

We in America pride ourselves on the progressiveness of our manufacturers and their desire to improve machinery and the better ways of doing things that have already been done well before. We have seen progress in many lines due to the help of electricity, but few can surpass the electrification of the steel industry.

The steel mill engineers recognize the possibilities of electric power and were willing to test electric motors on the different machines used in the manufacture of steel, and this co-operation with the electrical manufacturers has made the steel industry of the most highly developed today.

The first electric motor was installed in the Edgar Thompson Works, of the Carnegie Steel Company, at Bessemer, Pa., in 1891, and it is interesting to note that these historic machines were used for over twenty years. The application of the electric motor to the various machines increased rapidly until only the problem of electric drive for the main rolls remained. Here was a big problem—an enormous amount of power was required to operate the big rolls and the severe service seemed almost beyond the scope of electric motors. Especially did this idea apply to the reversing mill, where rapid and frequent reversing and severe peak loads, with extreme mechanical shocks and strains, are encountered.

The problem was not passed by, but accepted by the electrical manufacturers, and in 1905 the Westinghouse company successfully applied two 1,500-horsepower motors to a light-rail mill, and in 1907 installed an 8,000-horsepower reversing mill equipment on a 30-inch universal plate mill.

Electric drive has many advantages, but there are three fundamental advantages which have resulted in electricity being universally adopted in the steel industry. They are as follows:

1. The adoption of electric drives secures the most practical and economical method of generating power. We all know that there is economy in the central station generating electricity. A central station comprised of steam turbines, fed from boilers fired with coal,

will show a decided economy of steam consumption and general expenses. It has been determined from actual tests that in the majority of steam engine driven mills, the steam consumption could be reduced fully 50 per cent, if the mills were electrified and power was furnished from a central power plant with turbine units of 5,000 kw. or greater. In the case of engine driven the average load is not more than 30 to 40 per cent of the normal rating of the engine, although the peak loads may require the full capacity. With electric drive the peak loads of the various machines overlap, as they do not all occur at the same time and the load on the turbines becomes more uniform.

Further economies are possible in most steel plants, as the heat in the boilers can be obtained from some other source than coal, namely, by the utilization of gases and heat that are otherwise wasted. These methods follow:

(a) Blast furnaces and coke ovens are generally adjacent to or in close proximity to the steel mill, and the gases from these sources can be burned under the boilers, thus providing steam for the turbine generators.

(b) Boilers can be heated by the gases from open-hearth and reheating furnaces, and this steam can be utilized for the turbine generators.

(c) The exhaust steam from existing non-condensing reciprocating steam engines can be used to drive low-pressure turbine generators.

(d) The gas from blast furnaces can be used to drive gas engines.

2. Electric drive provides an economical and convenient means of power distribution. Electricity can be transmitted from the powerhouse to the point of application with small loss, rarely exceeding five per cent, an economy which cannot be realized with steam. The cables carrying the electric power can be readily installed in unobtrusive places to reach any point. With other forms of power the transmission is often a matter of considerable inconvenience and expense.

3. The use of electric power greatly reduces maintenance, repairs and attendance charges, and requires less supplies, such as oil, waste, packing, etc.

Electric power insures greater reliability of operation, as excessive shocks on the mill are avoided, due to the uniform torque of the motor. Much less wear and breakage is the result. An electric motor has a more uniform rate of acceleration under heavy load conditions, which reduces cost of operation. Especially is this true in reversing mills. The reversing is accomplished without the usual hammer blow effects.

With the improved speed conditions of the motor-driven mill, the output is increased and the quality of the product is improved. One very interesting point is, that the mill can be checked easily for friction losses and adjusted to give minimum losses. Electrical measuring instruments can be placed near the operator and data may be secured continuously of the amount of power consumed in the friction losses, which generally average from 15 to 30 per cent of the capacity of the driving unit. The friction losses may, in sheet-mill drive, be as much as 45 per cent. The losses will be more if the mill is not kept in alignment. With electric drive there is no tendency for the motor to slow down or to stall under excessive load requirements, nor does the motor race when steel leaves the rolls.

With the large motor units it is very desirable that some method be used to keep down the current peaks due to a sudden increase in the load. The Westinghouse company has gotten up a system of control to eliminate the peaks and equalize the load taken from the line. The result is accomplished by a flywheel. Although the load at the mill shaft may vary from several thousand horsepower, the demand from the line will only increase slightly. When the load comes on, the regulator tends to reduce the speed of the alternating current motor and the flywheel gives up its energy, and during the period of light load, the speed of the induction motor is increased, thus storing up energy in the flywheel.

Association of Railway Electrical Engineers.

At the eleventh annual convention of the above association held in Chicago recently, among the committee reports presented there were three covering the various phases of electric-headlight operation and one on the subject of railroad electrification. The question of electric-headlight operation was of particular interest this year as the time is rapidly approaching when all locomotives must be equipped with high-power headlights to conform with the ruling of the Interstate Commerce Commission. The standards recommended by the Committee on Electric Headlights included those for generator base-plates, steam-pressure ranges, ball bearings, brush sizes and steam-pipe openings. The report of the Committee on Railroad Electrification contained a typical skeleton form for an electrification report, which was intended to serve as guide in procuring all data necessary to an intelligent and comprehensive conclusion and recommendation, together with a bibliography of articles and papers, referring to steam-railroad electrification which have appeared in the American and foreign technical press during the years from 1908 to 1919.

The need of information on these subjects is a growing one, and not always easily obtainable, but the Association of Electrical Engineers are meeting the situation in a manner that gives assurance for future requirements.

Restoration of the French Railways.

A recent issue of *Le Gené Civil* gives a complete résumé of the work which has been done towards the restoration of the internal methods of communication of northern and eastern France that had been destroyed by the German invasion. The lines of the Northern and Eastern systems suffered the worst. On the former 2,000 miles were destroyed or put out of commission, and on the latter 1,400 miles. In addition to this 1,510 bridges, 12 tunnels and 590 buildings had been destroyed.

The work of restoration was started in 1918 by the French, English and American troops, assisted by the railway forces and pushed with great energy. At the time of the armistice a certain amount of temporary repairs had been effected, but there still remained on the Northern alone 350 miles of double track and 320 miles of single track to be put into usable condition.

On the first of September nearly 350 miles of double track and all of the single track had been rebuilt.

On the Eastern line 475 miles of double track and 90 miles of single track have been rebuilt.

Some of the principal viaducts and bridges have been rebuilt, among them being that of St. Benin, 570 feet long, on the main line between Paris, Liege and Cologne.

To appreciate the results obtained in this reconstruction of the railways, it is necessary to bear in mind the magnitude and the exceptional nature of the destruction effected by the enemy and the difficulties encountered from the outset.

Among these is that of housing and feeding a numerous working force in a country utterly deprived of all shelter and of every resource. The insufficiency of means of transportation over the highways, which were frequently in such condition that that material and tools needed for the simultaneous repairing of different works could not be hauled over them, resulting in a loss of time that could not be avoided.

Use of Electricity on the British Railways.

With the exception of 18 miles of mineral line between Shildon and Newport which has been electrified by the North-Eastern Railway with great success, all the electrified railways in Great Britain are of the suburban type in that they are worked on the multiple-unit system, each unit consisting of a motor coach hauling or pushing one, two or three trailers, these units being made up into trains of any length required to suit the traffic conditions, capable of being driven from either end whatever the formation be, and readily adaptable to varying traffic.

Snap Shots

By the Wanderer

At a recent meeting of engineers a professor of economics from a big university had been talking about the labor situation. He was well equipped for his work, having been secretary to a labor board in the shipbuilding struggle. He threw no fits, but stuck to facts. He presented them in the cold-blooded way that is especially pleasing to such an audience, and then, at the end threw open the doors to questions. He had not argued for or against government control. He had simply told facts. When he was asked what reason he would give for the fact that since the government control of certain large industries, the efficiency per man-hour had fallen off nearly fifty per cent. and the efficiency of the dollar about seventy per cent., he placed the whole responsibility on the men in control. He said that the government had appointed men to positions of control who were totally unfitted for their work; men who knew nothing of the industry they were to guide. Then, with a frankness that bespoke the earnestness of his conviction he quoted his own case. He said that the secretary of a shipbuilding board should know something about shipbuilding, whereas he had gone to his work without the slightest knowledge of the fundamentals of the business.

Does the manipulation of the throttle have anything to do with the leaking of tubes? It seems reasonable that it should. It will probably be readily granted that there is a difference between the temperature of the tubes and the shell. If there is, and the tubes are the hotter, then they should be the longer and be putting a pressure on the tube sheets in their effort to expand more than these sheets are moved by expansion of the shell. If this pressure were to be constant the effect on the tube fastening would depend upon its intensity, but it is hardly possible that it can be constant. When the throttle is closed the fire dies down, the temperature of the firebox falls and with it that of the tubes, which are more quickly affected by such a change than the shell, and there should be a relative contraction. When the throttle is opened the fire is brought very quickly into a condition of intense combustion, the temperature of the firebox rises several hundred degrees and with it the temperature of the tubes. How much these remain above the temperature of the shell during a protracted opening of the throttle is not known, but there have been certain indications that there is a tendency to an equalization of these temperatures under such conditions, and, if this does occur, then the pressure of the tubes on the sheets should be relieved.

It will probably be granted by all that a variation in conditions is anything but conducive to good results in boiler stresses and it, therefore, follows that running with a uniform throttle opening is one of the ways of avoiding such variations and is a matter of enough importance to warrant the careful attention of engineers and motive power officers.

A change of throttle opening or of reverse lever position means a change in exhaust intensity and draft, followed, probably, by a variation in pressure on the tubesheet, and this may even amount to a reversal of stress and we all know that this is to be avoided in all structures as much as possible. So leaky tubes may be, in cases, merely a function of throttle and reverse lever manipulation.

In my wanderings to and fro over the face of the earth I run through many interesting experiences and not the least of them is the disinclination or the fear of the union man to do anything that seems to infringe upon the other fellow's prerogative or job, especially job. In jotting down these experiences for the information and possible amusement of those who chance to read them I have usually followed the worthy example of the immortal Sairy Gamp and named no names. But I had a case the other night that really seems worth giving a local habitation and a name.

So here goes. It was at Buffalo, in the New York Central Station. There was two long lines of passengers lined up before two sets of deliberately acting ticket inspectors of sleeping car rights. Over the head of one set hung the signs "New York Sleepers" and "Albany Sleepers." Over the head of the other hung the sign "Boston Sleepers." The crowd gave a good sample of natural selection and took their proper places. I was going to Albany and dropped into the rear of a line of about fifteen. After a time I presented my credentials and was informed that I belonged to the other line.

"But your sign says here."

"Yes, I know. He ought to change it."

"But he hasn't."

"Well, that's none of my business."

Not much satisfaction in that. I took my place at the end of the other queue, this time about twenty deep.

But "time and the hour runs through the roughest day," and at last I presented my credentials to the proper official. Then this.

"Your sign is in the wrong place."

"Yes I know, but I didn't put it there."

"And I don't suppose you care a damn."

"Why should I? It's not my place to hang those signs, and the man who did it got them up wrong."

"Only that it would be something of a favor to the passengers to put it right."

Derisive laughter on the part of the official, and an expression of pitying interest on the faces of the listening passengers, that any one should be so foolish as to expect a suggestion to a government employe to take effect.

I had evidently said enough, so I went humbly on, and wondered what manner of men these were who would deliberately and knowingly allow a score or more of passengers to stand in line for from eight to ten unnecessary minutes each, rather than reach up and slip a sign five feet along a wire because forsooth that particular job was that of another man.

But why should I be surprised when every effort is made to prevent a machinist from driving a nail on which to hang his hat because that is a carpenter's job.

Corrosion of Iron and Steel.

At a recent meeting of the Barrow Society of Engineers in England Mr. H. B. Weeks delivered an address on the subject of the corrosion of iron and steel, in which he called attention to a process for the prevention of corrosion developed by Dr. Angus Smith, which had proved very successful in preserving underground iron. In this process, coal tar was boiled until all the water, the ammoniacal liquor and the lighter oils were expelled, and the prepared tar was applied to the cast-iron fresh from the mould. This was an ideal process for the protection of water pipes. The latter were heated to 300 deg. F. and were then lowered into the tar heated to the same temperature, and allowed to remain in it until the hot and fluid tar had soaked into the pores of the metal. The process when carried out properly was very efficient, and he knew of no better means of protecting iron and steel from atmospheric corrosion. It should be noted, however, that the means of application were more important than the so-called solution itself; the solution simply applied with a brush was not Dr. Angus Smith's process at all.

It will thus be seen that it is not always the material that is at fault, but that the means of application, involving painstaking, and that degree of care that is the very opposite of slip-shod methods of perfunctary performance, sometimes too common even in the simplest mechanical application, in the working and preservation of the various metals.

New Electric Welding Box

By J. Snowden Bell

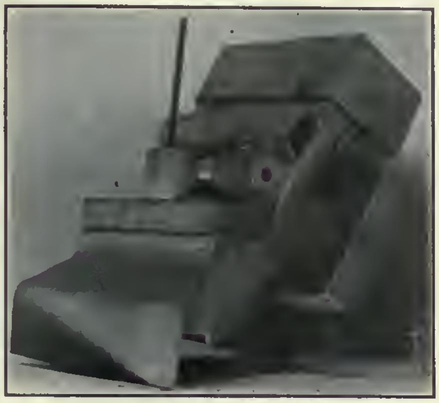
The electric welding box which is shown in the accompanying illustrations has been in use for some time past, at the Schenectady Works of the American Locomotive Co., in electrically welding superheater pipe supports, and has been found very satisfactory in operation. It is also being tested at the Mount Clare Shops of the Baltimore & Ohio R. R. It is simple in construction, consisting of a sheet metal box, with side and end shields, and an upwardly extending case or "cupola," in the top of which, colored observation glasses are fitted removably. The cupola is inclined at such an angle as will be adapted to bring the electric arc in the line of vision of the operator, when the work is in a waist high position. Ventilators on the sides of the cupola carry away the gases developed in the welding operation, and the welding wire passes through a socket at the front of the box.

In the ordinary electric welding practice, the electrode is located in a holder which is connected to the source of current, and manipulated by the operator, who wears a helmet, and observes the work through glasses therein, of suitable color, which act as eye pieces. The arc is not enclosed, and is consequently a source of danger to persons in the vicinity

WELDER AT WORK WITH CASE COVERING THE ARC.

of the operation, by reason of its injurious effect on the eyes. This objection is eliminated by the box illustrated, as the case covers the arc, while the weld is being made, thus cutting off the injurious light rays.

Among the advantages of this design, the following may be enumerated: The work is done under the cover of a case, giving protection to workmen near to it, and passers-by, from injurious rays of light, and the welding operation may be



BOX-SHAPED ELECTRIC WELDING CASE.

safely performed in crowded quarters or in the open street. A steady and positive support for the wire is provided, enabling the operator to maintain a constant length of arc, and minimizing personal and fatigue factors, thus effecting a stronger and more ductile weld. The operater is relieved from the helmet heretofore used, which tends to increase comfort and speed, and less experienced help may be availed of. In special repetitive work, the case will act as a jig for locating welds, and, in the welding operation, the case and cupola becomes filled with an iron vapor which drives out the air, permitting the weld to be made more durable, by reason of being done under conditions which minimize or eliminate the passage of oxygen or nitrogen into the welding metal.

Any information desired as to this welding box can be obtained from its designer, Mr. Ralph P. La Porte, 636 Rugby Road, Schenectady, N. Y.

The Surty Cone Belt Shifter.

Accident statistics show that thousands of workers have been incapacitated by having their thumbs torn off, or arms mangled and twisted out of shape in adjusting the speed of cone driven machines.

These accidents all belong to the preventable class and could have been prevented if an efficient, safe and fool proof belt shifter were used on the machines.

Before a belt shifter can be approved and labeled as such by the Underwriters' Laboratories it must comply with the following requirements:

(1) Device should operate positively and promptly at all times without any necessity of operator touching the belt with his hand.

(2) Device should be such that the operator can quickly manipulate any change of speed of belt required, from his normal working position at machine, obviating any necessity of his approaching the belt.

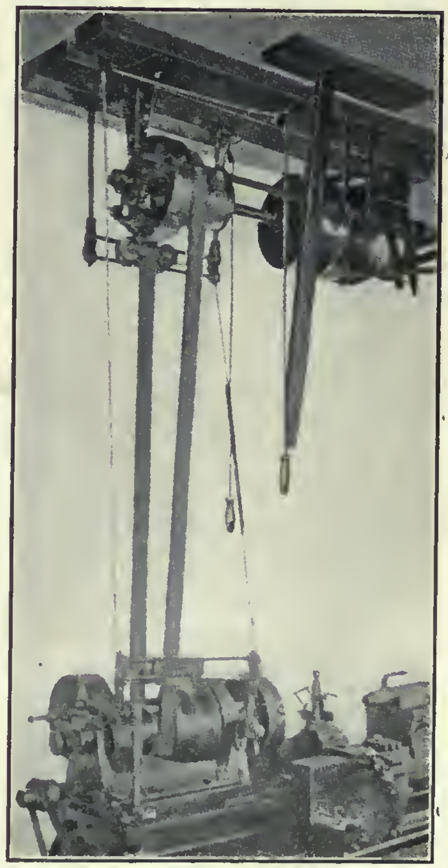
(3) Device should be so constructed as to cause the least possible wear or fraying of the edge of the belt.

(4) It should be possible to guard the belt with mesh material and leave no necessity for operator to open the guard, except for making immediate repairs.

The Surty Cone Belt Shifter illustrated in this article has passed the above requirements and was awarded the Underwriters' Laboratories label of approval.

A cone driven machine equipped with such a belt shifter is made equal in production to any selective gear drive, at much less first cost and more economy of workmen's time. It reduces the fatigue of the operator, also eliminates the possibility of accident.

The Surty cone belt shifter will instantly throw the belt from high speed to low, or low to high or to intermediate step, without the operator leaving his working position. In the hands of a workman who senses the need of more or less speed, it adds to the output of ma-



THE SURTY CONE BELT SHIFTER.

chine. The belt shifter can be applied to all lathes, milling machines, shapers and drill presses.

The Surty Cone Belt Shifter is also made for engine lathes, and is so sturdily designed and constructed that it should possess a long period of usefulness.

Electrification of French Railways.

The Paris, Lyons & Mediterranean Railway of France has had a project on hand for some time for the electrification of about 620 miles of its line. A year ago and almost immediately after the signing of the armistice a committee of engineers was sent to the United States to study what had been done here and report on what they found. This committee reached New York last April and their itinerary included visits and inspection of the New York Central, using a direct current of 600 volts through a third rail; New York, New Haven & Hartford, with a single-phase, 25-cycle current of 11,000 volts; Pennsylvania and Long Island also using a direct current of 600 volts and a third rail; the Chicago, Milwaukee & St. Paul using a high tension direct current of 3,000 volts; the Norfolk & Western using a single-three phase current of 11,000 volts between Bluefield and Vivian; the Pennsylvania line between Philadelphia and Paoli using a single-phase current of 11,000 volts, and the Baltimore, Washington, Annapolis interurban line using a 1,200-volt direct current. They also made a study of the more important of the large power generating plants as well as of the shops of the manufacturers and railway companies.

M. Mauduit, professor of the faculty of science at Nancy, has presented a report, in the name of the committee, to the Minister of Public Works, the conclusions of which should be of interest to American readers. He says that, owing to the remarkable results obtained by the Chicago, Milwaukee & St. Paul Railway with a direct current of 3,000 volts, the committee has no hesitation in recommending that system, which it considers to be the only one adapted to trunk line work.

It is possible that the single-phase system, which, at first sight, offers the advantage of a great variety of combinations, may some day reach a point of satisfactory operation, but there is no doubt, whatever, that in its present state of actual practical operation it is far from being in a desirable shape.

The direct or continuous current has the disadvantage of being more expensive in first cost, because of the necessary sub-stations and rotary transformers which are essential for changing the three-phase 50-cycle current usually generated at the central stations. In this connection, it may be remarked that in order to take advantage of the single-phase economies, it is possible to generate this current direct at low frequency, but if it is desired to utilize the usual 50-cycle current generated at the central stations, it will be necessary to use rotary converters with the single-phase as well as with the direct current. From this standpoint the direct current possesses the advantage of making it possible to use the current from any central station whatsoever, under the same conditions.

As far as the expense of operation is concerned, the estimates of the engineering departments of the several companies make a comparison of the different systems possible. From this the committee estimates that the differences will not be great enough to influence the choice of the system.

The almost complete absence of any disturbances on the telegraph and telephone lines gives the direct current a very considerable superiority over the others.

They pass over the three-phase system, which has only been applied in America to an insignificant extent. In spite of certain advantages obtained by the Italians, it is rejected because of its complications, its high first cost, as well as that of the maintenance of the two lines of contact.

From the standpoint of economy, the reports on this subject, brought from America, are far less complete and accurate than are those giving the engineering data.

On the other hand, in order to draw a conclusion, from experience in America, as to the economic future of European traction, it is necessary to make a very considerable modification in the figures that have been presented, because of the two principal constants that differentiate between American and European operation.

In the first place, the couplings used between the cars in American practice have a breaking resistance of about 300,000 lbs., and can be subjected to a tractive effort of 100,000 lbs. In Europe two kinds of couplings are in use, whose breaking resistance is 75,000 lbs. and 110,000 lbs., respectively, and the tractive effort is limited to 22,000 lbs., except in Switzerland, where it rises to 26,000 lbs. and 33,000 lbs.

Secondly, in America all freight and passenger cars are fitted with the air brake.

The result is that in America they use locomotives two or three times as powerful and haul freight trains two and three times as long and as heavy as they do in Europe, and that freight train crews are correspondingly less numerous in their personnel, which makes a complete modification in operating expenses.

Accurate calculations made by the several companies, especially as to the results of the earlier electrifications, coupled with a consideration of the cost of coal, simply make it possible to state, that, under some conditions, electric traction will be more economical than with steam locomotives. Furthermore, it is already well known that the saving will be especially noticeable on lines having heavy grades and a dense traffic and it is probable that, on many lines where these conditions are wanting, electric traction will be more expensive than that of steam locomotives.

Finally, the necessity, which is becoming more and more important, of economizing in the use of coal as well as the well-known incidental advantages attendant upon electric traction, reaches a start in the execution of the first stages of its application desirable, with the end in view of the progressive electrification of the most interested of the French lines such as the Paris & Orleans, Paris, Lyons and Mediterranean and Midi systems.

Railway Supply Manufacturers' Association.

An official circular has been issued by the Railway Supply Manufacturers' Association extending a cordial invitation to manufacturers and dealers in railway supplies to exhibit at the Convention of the Association to be held at Young's Pier, Atlantic City, N. J., in conjunction with the American Railroad Association, Section III—Mechanical, and the American Railroad Association, Section VI—Purchases and Stores, June 9 to 16, 1920. The membership dues and price of badges will remain as formerly, the former twenty-five dollars annually and the latter five dollars each, and concerns who may not exhibit but wish to endrol as a member, should designate the name of their voting delegate. Exhibit spaces will be assigned by the Exhibit Committee at the office of the Association, 1841 Oliver Building, Pittsburgh, Pa., March 12.

There is every assurance that the same hearty co-operation and support on the part of the Railroad Associations that so particularly manifested itself last year will be examined, and the fact that several other associations of railway mechanical men are taking the necessary steps to become affiliated with Mechanical Section III, is an assurance that the attendance of the leading railroad men who are interested in mechanical equipment will be much larger than usual. Full particulars in regard to exhibit spaces, arrangements and delivery of materials, hotels and rates, furniture and furnishings and other matters of interest may be had on application to Mr. J. D. Conway, Oliver Building, Pittsburgh, Pa.

International Pipe Threads Standard.

At a recent meeting of the American Society of Mechanical Engineers, the committee on international standard of pipe threads held a public hearing in the Engineering Societies' Building, New York. Resolutions were adopted expressing the opinions and best judgment of American pipe industries, associations of engineers and others interested in the development of pipe fittings.

Items of Personal Interest

J. V. Bland, storekeeper of the Virginia at Sewalls Point, Va., has been appointed storekeeper at Roanoke, succeeding I. M. Mitchell.

I. L. Kline has been appointed car foreman of the Chicago, Milwaukee & St. Paul, with office at Perry, Iowa, succeeding Elmer Ricketts.

Lieut.-Colonel B. Ripley has been appointed district engineer on the Canadian Pacific, with office at Toronto, Ont., succeeding A. L. Hertzberg, retired.

I. M. Mitchell, storekeeper of the Virginia at Roanoke, Va., has been transferred to Victoria, Va., succeeding K. A. Fernstrom, assigned to other duties.

C. A. Worth, acting master mechanic on the Paseo division of the Northern Pacific, has resumed his former position as road foreman of engines on the Frisco division.

J. E. Daniels has been appointed traveling engineer on the Chicago, Milwaukee & St. Paul, with headquarters at Three Forks, Mont., succeeding G. T. Spaulding, transferred.

G. W. Gilleland, master mechanic of the East Carolina division of the Seaboard Air at Andrews, N. C., has been transferred to the Virginia division, with headquarters at Hamlet, N. C.

M. P. Blauvelt, who recently resigned as assistant regional director of the Allegheny region, United States Railroad Administration, has been elected vice-president of the Illinois Central.

T. M. Price, master mechanic of the Seaboard Air Line at Hamlet, N. C., has been transferred to the Virginia division, with headquarters at Raleigh, N. C., succeeding F. L. Stockwell, resigned.

P. G. Winter has been appointed mechanical valuation engineer of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, Ill., succeeding W. F. Lynaugh, assigned to other duties.

I. B. Irvin has been appointed master mechanic of the Pittsburgh, Shawmut & Northern, with office at the Angelica shops, Angelica, N. Y., and the position of general foreman has been abolished.

J. A. Wright, general foreman on the Chicago, Milwaukee & St. Paul, has been appointed master mechanic at Tacoma, Wash., succeeding G. E. Cessford, transferred to a similar position at Bellingham, Wash.

G. T. Bourne, traveling engineer and train master of the Denver & Rio Grande, with headquarters at Soldier Summit, Utah, has been transferred to the Green River division, with the same headquarters.

L. H. Ledger, road foreman of engines of the first district, Arizona division, of the Atchison, Topeka & Santa Fe Coast Lines, at Needles, Cal., has been transferred to the second district, with the same headquarters.

B. J. Peaseley, master mechanic of the Vicksburg, Shreveport & Pacific, has been appointed superintendent of motive power, and of the Alabama & Vicksburg, and the Louisiana & Mississippi Transfer, with headquarters at Monroe, La.

F. T. Miller, master mechanic on the Chicago, Milwaukee & St. Paul, with headquarters at Marion, Iowa, has been transferred to Portage, Wis., succeeding M. F. Smith, who has been transferred to a similar position at Minneapolis, Minn.

K. C. Gardner, assistant manager of sales of the Pressed Steel Car Company, and the Western Steel Car & Foundry Company, has been appointed manager of sales for the Central district, with offices in the Farmers Bank Building, Pittsburgh, Pa.

E. A. CRAIG.

Huntley H. Gilbert, assistant manager of sales of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, has been appointed manager of sales of the Western district, with offices at 425 Peoples Gas Building, Chicago, Ill.

W. N. Pollard, division storekeeper of the Southern at Columbia, S. C., has been transferred to South Richmond, Va., succeeding W. F. Lamb, deceased, and I. H. Smith has been appointed division storekeeper of the Southern at Columbia, succeeding W. N. Pollard.

R. G. Bennett, master mechanic on the Pennsylvania, with office at Pittsburgh, Pa., has been appointed superintendent of motive power of the Eastern Pennsylvania division, succeeding E. W. Smith, transferred. F. S. Robbins succeeds Mr. Smith as master mechanic at Pittsburgh.

James H. Hustis, formerly president of the New York, New Haven & Hartford, and also president of the Boston & Maine, and latterly director of the New England district, United States Railroad Administration, has again been elected president of the Boston & Maine. Mr. Hustis is from New York, and has occupied many positions in railroad service, particularly in the transportation department.

N. P. White, roundhouse foreman on the Lake Superior division of the Northern Pacific, has been appointed master mechanic of the Minnesota division, with office at Staples, Minn. J. A. Marshall, road foreman of engines at Duluth, Minn., has been appointed acting master mechanic of the Lake Superior division, and C. P. Cunliff, locomotive engineer, has been appointed road foreman of engines on the same division. Luke J. Gallagher, locomotive engineer, has been appointed road foreman of engines on the Rocky Mountain division, with office at Missoula, Mont.

E. A. Craig has been appointed export manager of the newly organized export department of the Westinghouse Air Brake Company, with headquarters in the Westinghouse Building, Pittsburgh, Pa. Mr. Craig has been associated with the company for thirty years, and during that time has served as auditor and assistant secretary, and in 1906 was appointed Southwestern manager of the company. The export department will be represented in the New York office by W. G. Kaylor, and in South America by R. M. Gates. The Westinghouse companies control the following foreign companies: The Compagnie des Freins Westinghouse, Sevran, France; the compagnia Italiana Westinghouse dei Freni, Turin, Italy; the Westinghouse Brake Company of Australasia, Ltd., Concord West, New South Wales, Australia; the Westinghouse Eisenbahn Bremsen Gesellschaft, Hanover, Germany; the Societe Anonyme Westinghouse, Petrograd, Russia; and the Westinghouse Brake Co., Ltd., of London, England, represented in China by Jardine, Matheson & Company, Ltd., Shanghai; in Denmark and Sweden by Frants Alling, Puggaardsgade 4, Copenhagen; in Holland by Vaillant and Sluyterman, Noordeinde, 18a, The Hague; in Japan by Sale and Frazar, Ltd., Yaesu Cho, Tokyo; in Norway by "Vulkan," Jernstoberl and mek. Vaerksted, Christiana, and in South Africa by Bellamy and Lambie, 621 Consolidated Buildings, Johannesburg.

OBITUARY

William T. Gorrell.

The death is announced of William T. Gorrell, formerly master car builder of the Philadelphia & Reading. He was over 40 years in the employ of the company, passing through various positions in the car department and was appointed master car builder in 1897, resigned in 1914, and died at his home in Reading, Pa., on December 13, 1919, at the age of 76.

Albert Schmid.

Albert Schmid, consulting engineer of the Westinghouse Company, died on December 31, 1919. Mr. Schmid was born in Zurich, Switzerland, in 1857, and began his engineering career in the employ of the French Westinghouse Air Brake Company, and came to America in the early 80's. His rare mechanical insight brought him rapid advancement. He invented and perfected many important improvements both in the air brake and in the electrical departments. He was particularly successful in the original development of many forms of electrical apparatus, and indelibly impressed his engineering genius upon much of the advanced progress of the leading engineering work of our time.

Locomotive Terminal Equipment Association.

An association composed of a large number of leading railroad equipment manufacturers and others particularly interested in the betterment of locomotive terminal equipment has been incorporated with headquarters in the Lytton Building, 14 East Jackson Boulevard, Chicago, Ill. The object is to make surveys for and distribute data concerning the improvement of locomotive terminals in order to secure speedy, efficient and economical handling, cleaning, repairing and returning to service of locomotives; such data to be impartially secured and published without advertisement or especial advantage to any individual, firm or corporation, that may be a member of the corporation. There are two classes of members —active and honorary, the active members being confined to firms or corporations regularly engaged in the manufacture or sale of locomotive terminal equipment, or interested in the construction of locomotive terminals; the honorary members being elected at the discretion of the board of directors. The following have been elected officers and directors of the association for 1920:

President, William R. Toppan, manager, railroad department of the William Graver Tank Works, Chicago. Vice-president and secretary, Bruce V. Crandall, Chicago. Treasurer, John S. Maurer, secretary and treasurer of the National Boiler Washing Company, Chicago. General Counsel, Frank J. Loesch, 1540 Otis Building, Chicago. Spencer Otis, president of the National Boiler Washing Company, Chicago; William Robertson, of Wm. Robertson & Company, Chicago; Frank W. Miller, of the F. W. Miller Heating Company, Chicago; Robert A. Ogle, president of the Ogle Construction Company, Chicago, and Norman S. Lawrence, vice-president and assistant sales manager of Whiting Laundry Equipment Company, Harvey, Ill.

The board of directors will meet monthly and the first annual meeting will be held in December, 1920.

Changes in the Staff of the Westinghouse Air Brake Company.

Among the changes in the personnel of the Westinghouse Air Brake Company the following are announced:

G. R. Ellicott has been appointed manager of the Eastern district, succeeding J. R. Ellicott, retired. C. H. Beck succeeds G. R. Ellicott as assistant Eastern manager, with headquarters at New York. Robert Bingers becomes southeastern manager, with headquarters at Munsey building, Washington, D. C. A. K. Hoymeyer, representative at the Chicago office, is promoted to the position of assistant western manager. J. B. Wright, assistant southeastern manager, is made assistant district manager at Pittsburgh. F. H. Parke, resident engineer, southeastern district, is appointed general engineer, with headquarters Westinghouse building, Pittsburgh. T. W. Newburn, assistant engineer, southeastern district, becomes district engineer, southeastern district, with headquarters at Munsey building, Washington. J. C. McCune, special engineer, Wilmerding, is appointed assistant to district engineer, eastern district, with headquarters at 165 Broadway, New York, and J. H. Woods of the Commercial engineering department, Wilmerding, is appointed engineer, Export department, with headquarters at the Westinghouse building, Pittsburgh.

Special Committee for the Next Convention, Section III—Mechanical.

The Executive Committee of Section III.—Mechanical, of the United States Railroad Administration has appointed special committees to report on the following named topics, and to which the names of the chairmen are appended:

Auxiliary or Safety Connection between Engines and Tenders—M. H. Haig, mechanical engineer, Atchison, Topeka & Santa Fé, chairman.

Depreciation of Freight Cars—C. E. Chambers, mechanical assistant to director of Allegheny region, United States Railroad Administration, chairman.

Design, Maintenance and Operation of Electric Rolling Stock—C. H. Qureau, superintendent of electrical equipment, New York Central, chairman.

Engine Terminals, Design and Operation—C. E. Fuller, superintendent of motive power and machinery, Union Pacific, chairman.

Feed Water Heaters for Locomotives—F. M. Waring, engineer of tests, Pennsylvania, chairman.

Locomotive Headlights and Classification Lamps—H. T. Bentley, superintendent of motor power and machinery, Chicago & Northwestern, chairman.

Modernization of Stationary Boiler Plants—A. G. Turnbull, assistant to general mechanical superintendent, Erie, chairman.

Repair Shop Layouts—I. S. Downing, general master car builder, Cleveland, Cincinnati, Chicago & St. Louis, chairman.

Scheduling and Routing Systems for Locomotive Repair Shops—Henry Gardner, supervisor of apprentices and shop schedule systems, Baltimore & Ohio, chairman.

Standard Method of Packing Journal Boxes on Freight Cars—C. J. Bodemer, assistant superintendent of machinery, Louisville & Nashville, chairman.

Superheater Locomotives—H. R. Warnock, superintendent of motive power, Chicago, Milwaukee & St. Paul, chairman.

Car Construction—W. F. Kiesel, mechanical engineer, Pennsylvania, chairman.

Specifications and Tests for Materials—F. M. Waring, engineer of tests, Pennsylvania, chairman.

Car Wheels—W. C. A. Henry, superintendent of motive power, Pennsylvania Lines West, chairman.

Train Resistance and Tonnage Rating—O. P. Reese, Pennsylvania Lines West, chairman.

Mechanical Stokers—M. A. Kinney, superintendent or motive power, Hocking Valley, chairman.

Fuel Economy and Smoke Prevention—William Schlafge, general mechanical superintendent, Erie, chairman.

Train Brake and Signal Equipment—T. L. Burton, consulting air brake engineer, New York Central, chairman.

Autogenous and Electric Welding—J. T. Wallis, general superintendent of motive power, Pennsylvania, chairman.

Special papers are also expe[illegible] G. M. Basford, president Lo[illegible] Feedwater Heating Company, New [illegible]ork, on the "Modernization of Existing Old Locomotives," and a "Study of Locomotive Operation from the Point of View of a Large Investment," as well as a paper by J. S. Spurway, secretary New South Wales Government railways, on the subject of "Automatic Coal Weighing Devices for Locomotive Tenders;" and C. E. Fuller, superintendent of motor power and machinery, Union Pacific, is also preparing a paper on "Snow-Fighting Apparatus."

Other special papers may be expected from members of the mechanical societies becoming affiliated with Sec. 111, Mechanical U. S. Railroad Administration.

BOOKS, BULLETINS, ETC.

Annual Proceedings of the International General Foremen's Association, 1919. Compiled and published by William Hall, Winona, Minn. 170 pages, with illustration; flexible cover.

The proceedings of the fourteenth annual convention of the International General Foremen's Association, held in Chicago, Ill., September 2-5, 1919, are issued in a handsome volume and contain the reports of committees, standing and special, with full reports of the discussions on the various subjects reported on. A list of members, now numbering 221, and a copy of the constitution and by-laws is appended. The volume is finely printed on toned paper, and copies may be had from William Hall, secretary.

"Foundry Practice." A textbook for Molders, Students and Apprentices. By R. H. Palmer, Second edition. John Wiley & Sons, Inc., New York, 1919, Cloth, 6 x 8 in., 390 pp., illus., 40 tables.

This volume is intended primarily for purposes of instruction, rather than as a treatise for experienced foundrymen. The various types of molds are explained and illustrations of the different practices are given. Cupola and air-furnace practice, foundry equipment, methods of mending and cleaning castings are also discussed. This edition has been enlarged by the inclusion of methods for casting and holding a number of additional articles, such as engine cylinders, propellers, lathe beds, and large kettles. The book is not only an excellent treatise for those beginning to learn the details of moulding, but the experienced may learn much from its pages.

One Thousand Technical Books.

A selected list with annotations emphasizing especially elementary practical books. Compiled by Herbert L. Cowing. Washington, American Library Association War Service, June, 1919. 123 pages.

This is a useful list covering general engineering, civil, mechanical and electrical engineering, building, mining and metallurgy, chemical technology and miscellaneous industries. It has been carefully worked out and annotated. It was issued for use in the camp libraries of the army during the war.

Graphite.

Joseph Dixon Crucible Company, Jersey City, N. J., in the November-December, 1919, issue of *Graphite* is full of interesting matter. The advent of winter caused, as usual, a great demand for Dixon's Silica-Graphite Paint which has proven itself to be the best not only in resisting ice-bound winters but scorching summers. Those interested can have full information by addressing the company's Paint Department, No. 190-B.

"National" Bulletin.

The Rise of Steel Pipe is gradually set forth in the latest issue of the "National" Bulletin, published by the National Tube Company, Pittsburgh, Pa. Briefly the contrast between the use of iron and steel shows the decrease of the former metal from 500,000 tons to less than 250,000 in the last thirty years. The data in regard to the use of steel only covers about five years, but the output has already reached over 2,000,000 tons in 1918, and the demand increases. There is an abundance of matter on the bulletin tending to show the causes that have led to this marked increase in the use of steel. "National" Pipe is the highest development of the art of manufacturing durable pipe for all purposes.

Research Graduate Assistantships.

To assist in the conduct of engineering research, the University of Illinois maintains fourteen Research Graduate Assistantships in the Experiment Station, for each of which there is an annual stipend of $500. The appointments are open to graduates of universities and technical schools, and are made from applicants received by the Director of the Station each year not later than the first of March, and are made effective in September following. Among the studies that may be selected are mechanical and electrical engineering, railway engineering, and theatrical and applied mechanics. Full information may be obtained from the Director, University of Illinois, Urbana, Ill.

Staybolts.

The Flannery Bolt Company's *Digest* issued in December, 1919, announces the introduction of the "SM" cap for the Tate Flush sleeve. The "SM" is now made of a forging, and those observing a slight difference between the old and the new cap will understand that the forge cap supersedes the old. Interesting details of installation equipment is also furnished in the issue, copies of which may be had on application.

Accident Bulletin.

The report of the Bureau of Statistics of the Interstate Commerce Commission, as shown in Bulletin No. 70, covering the months of October, November and December, 1918, the number of persons killed is 2,371, and injured 18,875. While these figures are higher than some of the previous reports, it falls considerably below the average for several years. Among the elements of disaster, accidents caused by trains striking or being struck by automobiles shows a general increase, the total number of such accidents being 2,168. In the case of trains striking or being struck by trolley cars, the number is limited to 61, showing conclusively that automobile drivers are not at all comparable to train men or trolley drivers in the element of safety. Trespassers show a list of 810 killed and 578 injured. Of 80 locomotive accidents reported 47 are classified as locomotive boiler accidents, the breaking of the driving gear and machinery being the largest among the other items classified as causes of accidents.

Welding in Fireboxes.

The chief inspector of locomotive boiler has issued special precautionary suggestions in regard to autogenous welding on fireboxes, and has embodied the same in a code of rules well worthy of perusal, the most notable perhaps being recommendations that welded seams in crown sheets should not be used where full size sheets are obtainable, and that where a number of small patches exist the adjacent part of the sheet should be cut out and a new piece inserted.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXIII | 114 Liberty Street, New York, February, 1920 | No. 2

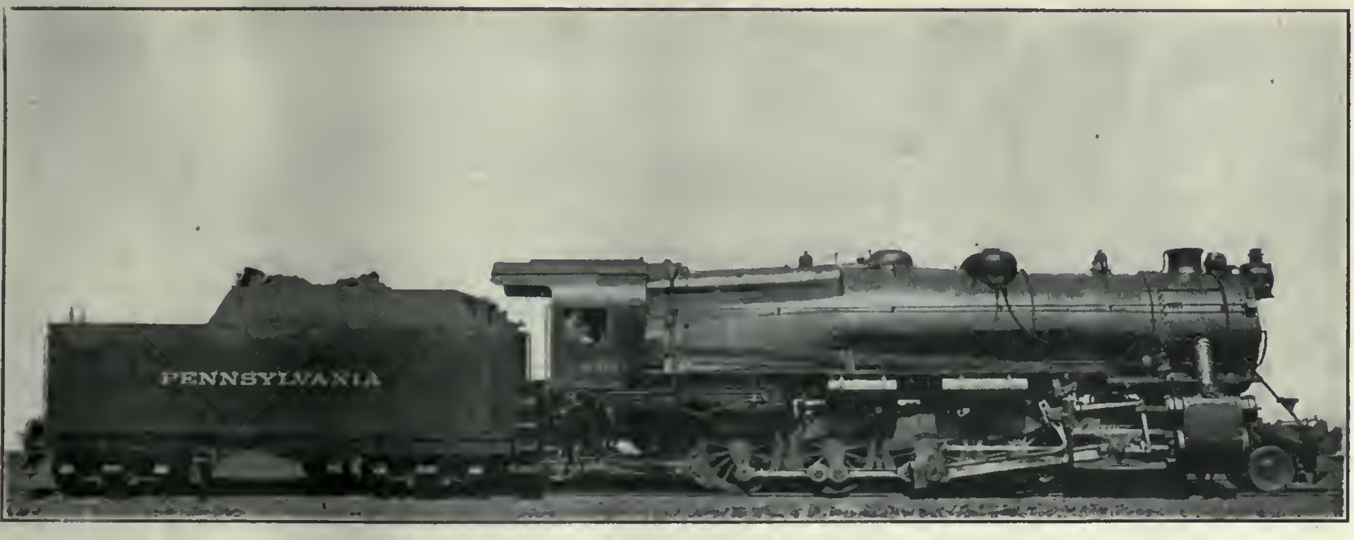
Tests of Decapod Type Locomotive

I1s Class of the Pennsylvania Railroad

The Pennsylvania Railroad officials created something of a sensation at the Atlantic City Convention in June by the exhibition of a Mallet locomotive which rather upset previous ideas of what a locomotive should be. It was not only a single expansion locomotive, but one so arranged that the maximum cut-off occurred at about half stroke. Its design in so far as the maximum cut-off is concerned was based upon a careful series of tests conducted with a Decapod locomotive having the same peculiarity as to its point of maximum cut-off, the other variations being as specified in the annexed table of dimensions.

The general dimensions of the two engines are as follows:

	Engine		Increase of I1S over L1S.
	790, HS	1752, L1S	Per cent
Weight in working order, total pounds	371,800	320,700	15.9
Weight on drivers, working order, pounds	342,050	240,200	42.4
Driving wheels, diameter, inches	62	62	....
Cylinders, diameter of stroke, inches	30½ x 32	27 x 30	37.6 vol.
Heating surface tubes (water side), sq. ft	4,043.94	3,715.71	8.8
Heating surface, firebox and arch tubes, sq. ft	290.20	301.51*	Dec. 3.8
Heating surface, superheater (fireside), sq. ft	1,478.91	1,171.63	26.2
Heating surface (water side of tubes), total, sq. ft	5,813.05	5,188.85	12.0
Heating surface (fireside of tubes), total, sq. ft	5,423.12	4,847.72	11.9
Grate area, sq. ft	70	70	....
Boiler pressure, lb. per sq. in	250.0	205.0	22.0
Valves	12-in. piston	12-in piston	....
Valve motion, type	Walschaerts	Walschaerts	....
Firebox, type	Wide Belpaire	Wide Belpaire	....
Tubes, number	244	237	....
Tubes, outside diameter, inches	2.25 & 5.5	2.25 & 5.5	....
Tubes, number for superheater	48	40	20
Tubes, length, inches	228.32	226.51	....



DECAPOD 2-10-0 TYPE LOCOMOTIVE, PENNSYLVANIA RAILROAD, BUILT AT COMPANY'S SHOPS, ALTOONA, PA.

Exhaustive comparative tests were made between the Decapod referred to and a Mikado locomotive of about the same cylinder capacities, with a slight advantage in favor of the Decapod. Comparative tests were also made with another ordinary engine having nearly the same size of cylinders. The Decapod is classified in the Pennsylvania nomenclature as an I1s and the Mikado as an L1s.

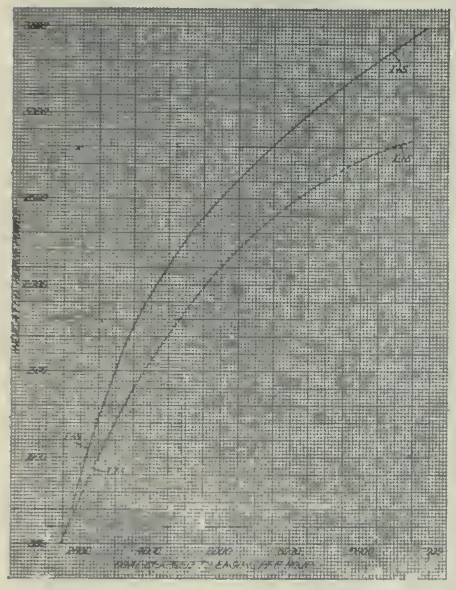
The superheater heating surface area of the L1s is given for that of the standard 17-foot superheater. This has been changed to an 18-ft. superheater, or the same as the I1s.

The bulletin containing a report of these tests has now been made public.

It is well known that it has been the custom to design locomotives with cylinders small enough to be operated with a cut-off of 90 per cent. without going beyond the limit of adhesion, with the result that, in service, they are operated at points far beyond the point of economical working. This is especially true of locomotives in helping service, which are worked, almost contnuously, with a cut-off near the end of the stroke, whereas if they were so designed as to work at but 50 per cent. cut-off, when in full gear, without a sacrifice of drawbar pull, there would be gained the difference between the coal and water rates at full stroke cut-off and those at half-stroke, or approximately 25 per cent.

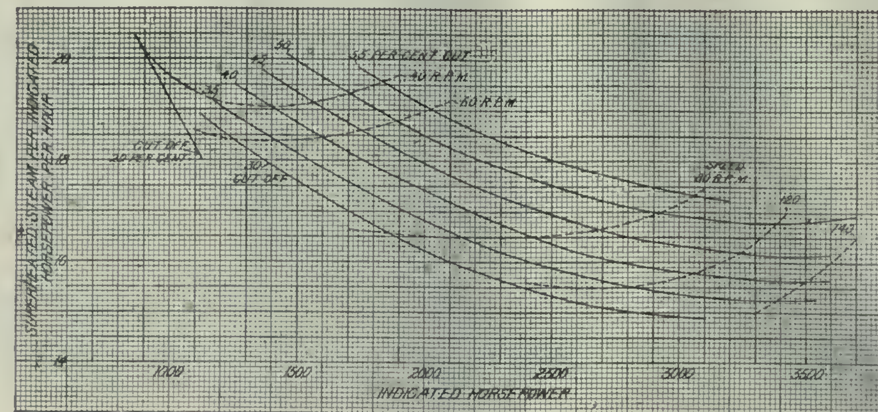
This was the principle underlying the design of the I1s decapod locomotive.

The maximum cut-off at one-half



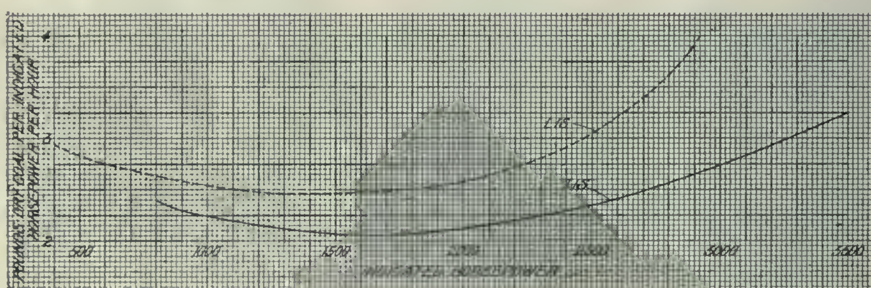
COAL USED PER INDICATED HORSE POWER.

stroke was obtained in the ordinary manner by simply increasing the steam lap of the valve. Then, in order to meet the requirements of starting an auxiliary port was cut in the valve cages 1¾ in. in advance of each of the main steam ports. These ports are intended for starting, but are, however, in action at all times when the engine is using steam. They are ⅛ in. by 1½ in. and are so located that the valve has a steam lap of ¼ in. This exceedingly small port, while quite sufficient to build up pressure in the cylinder equal to that in the boiler in a very short time when the engine is standing, is so small and admits such small quantities of steam that it produces no appreciable effect when the piston is in motion, and its influence cannot be detected



WATER RATES AT ALL CUT OFFS FOR I1S LOCOMOTIVE.

upon the indicator cards, examples of which are given in the accompanying engravings. These are taken for cut-offs of 20, 40 and 55 per cent., the latter being in full gear of 50 per cent. plus an allowance of 5 per cent. for the influence of the auxiliary ports. The speed at which these particular diagrams were taken is 40 revolutions per minute, which corresponds to 7.4 miles per hour.



INDICATED HORSEPOWER AND COAL USED.

This is, of course, at slow speed but it must be borne in mind that this design of valve gear is intended primarily for locomotives developing high power, either at low or high speeds, and for continuous heavy work. When used for high speed service, and it becomes necessary to cut back to less than 20% cut-off, it s preferable to make the reduction in power by means of the throttle rather than by cutting off earlier. Nothing is ganed in any locomotive by cutting off earlier than 20% of stroke rather than by throttling.

The bulletin of the tests deals with every feature, but the interest centers about the comparative savings effected by the Decapod in the production of a horsepower corresponding to that of the Mikado, with valves arranged for the usual amount of maximum cut-off.

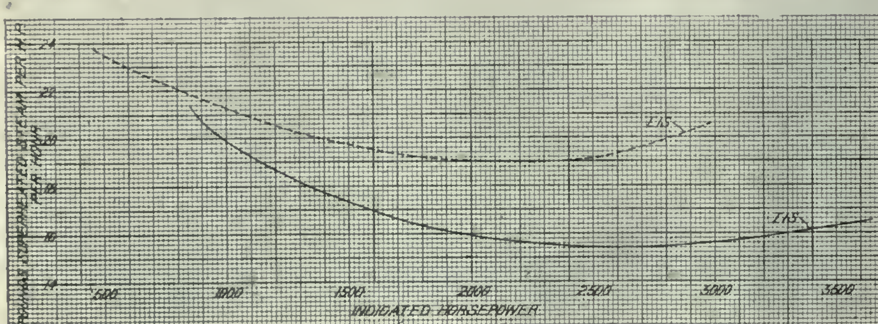
The coal used in the comparative tests with the Mikado locomotive was of the following composition:

	Per Cent.
Fixed carbon	56.21
Volatile combustible	31.34
Ash	11.67
Moisture	.97
Total	100.19
B. t. u. per lb. day	13,429
B. t. u. per lb. combustible	15,221

The high boiler pressure of 250 lbs. involved an increase of steam temperature to about 406 degs. Fahr., which is nearly 20 degs. above that of 200 lbs. pressure. Yet even with this a maximum superheat temperature of 282.8 degs. was obtained, which is nearly as high as has been obtained on any locomotive in the test plant, all of which have had a boiler pressure at or below 205 lbs.

The firing was all by hand, and the rate of firing reached 189 lbs. per hour per square foot of grate, and at this rate the evaporation per square foot of heating surface was 10.3 lbs. of water per hour.

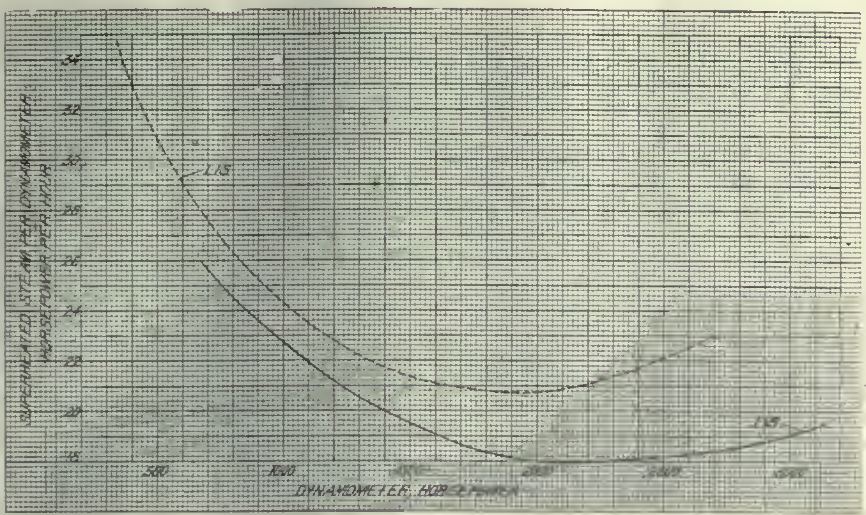
The tests have shown that the restricting of the cut-off has had the desired effect in that in full gear, where the bulk of the work is done, the I1s operates much more economically than the L1s. This advantage is reduced, as was to be expected, as the engines are cut back, but it is not until the point of cut-off has gone below the most economical point for



INDICATED HORSEPOWER AND STEAM CONSUMPTION.

both locomotives that the L1s became more economical at a given horsepower than the I1s.

Referring to the indicator diagrams illustrated, the principal point of interest lies in the action of the auxiliary port.



STEAM AND DYNAMOMETER HORSEPOWER.

It opens before the main port and has a lead of 1 15/16 in., as against 3/16 in. for the main port, and on the indicator diagram it appears as the amount of preadmission. But considering the cards for full gear, there is no evidence that the auxiliary ports admit a sufficient amount of steam to hold up the admission line appreciably, after the cut-off of the main port.

The diagrams of comparative performances here presented are taken from the bulletin, with the spotting of the individual tests omitted.

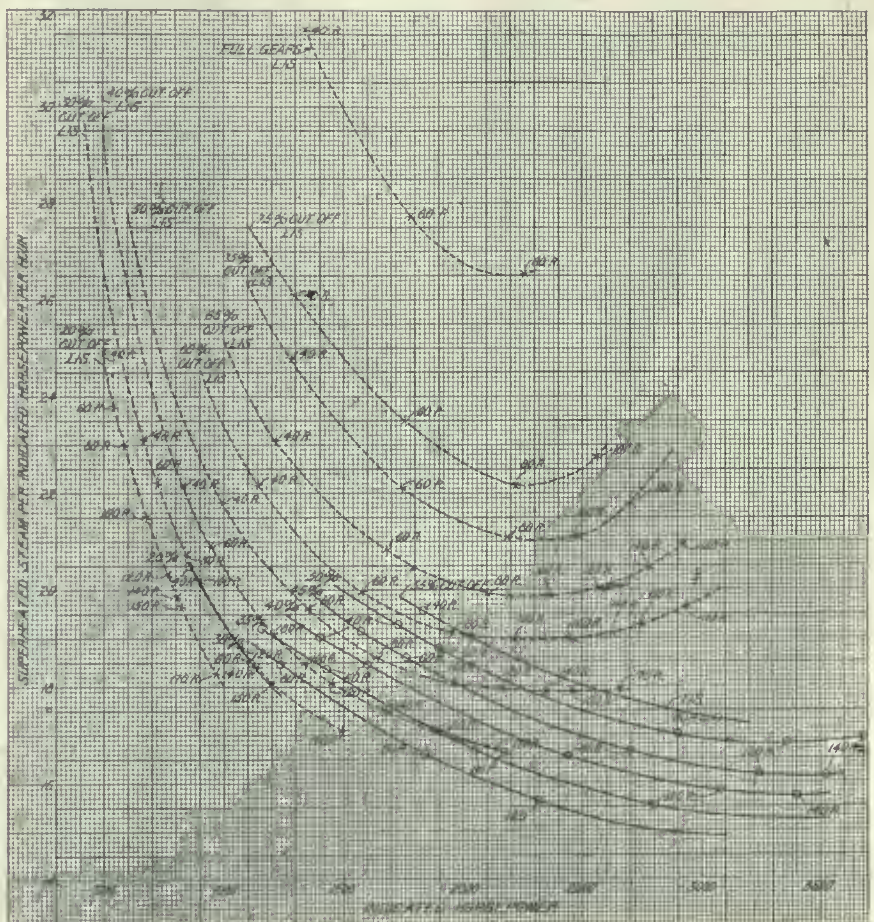
Referring to these diagrams of comparative performance, we will first consider that of the Coal to Engines and Indicated Horsepower. Here, at the low coal consumption of 2,000 lbs. per hour, the indicated horsepower of the two engines is the same, but when the coal consumption reaches 12,000 lbs. per hour, the Mikado (L1s) developed but 2,740 horsepower, as against 3,500 horsepower for the decapod.

The same advantage appears in the diagram of Indicated Horsepower and Coal. Here, again, at the low horsepower, the difference between the two engines is slight, being at 900 horsepower about 2.3 lbs. per indicated horsepower hour for the decapod and 2.6 lbs. for the Mikado. The difference between the two steadily increases until at 2,800 horsepower the decapod used 2.65 lbs. per horsepower, as against 4 lbs. for the Mikado. The greatest efficiency of the decapod was obtained at about 1,500 horsepower, where the coal consumption was about 2.05 lbs. per indicated horsepower.

This means that the reverse condition holds in the matter of steam consumption. That is, the greater the power developed the less will be the steam consumption of the decapod as compared with the Mikado. At 800 indicated horsepower the steam consumption of the decapod was about 21.4 lbs. of superheated steam per horsepower hour. With the Mikado it was 22 lbs. But at 2,900 horsepower, the decapod used 15.6 lbs., as against the Mikado's 20.2 lbs. The most economical use of steam by the decapod occurred at about 2,600 horsepower, when the consumption was only 15.4 lbs. per horsepower per hour. Attention may be directed here to the fact that a few years ago a consumption of 16 lbs. of steam per indicated horsepower hour was considered to be remarkably good practice for a Corliss compound engine.

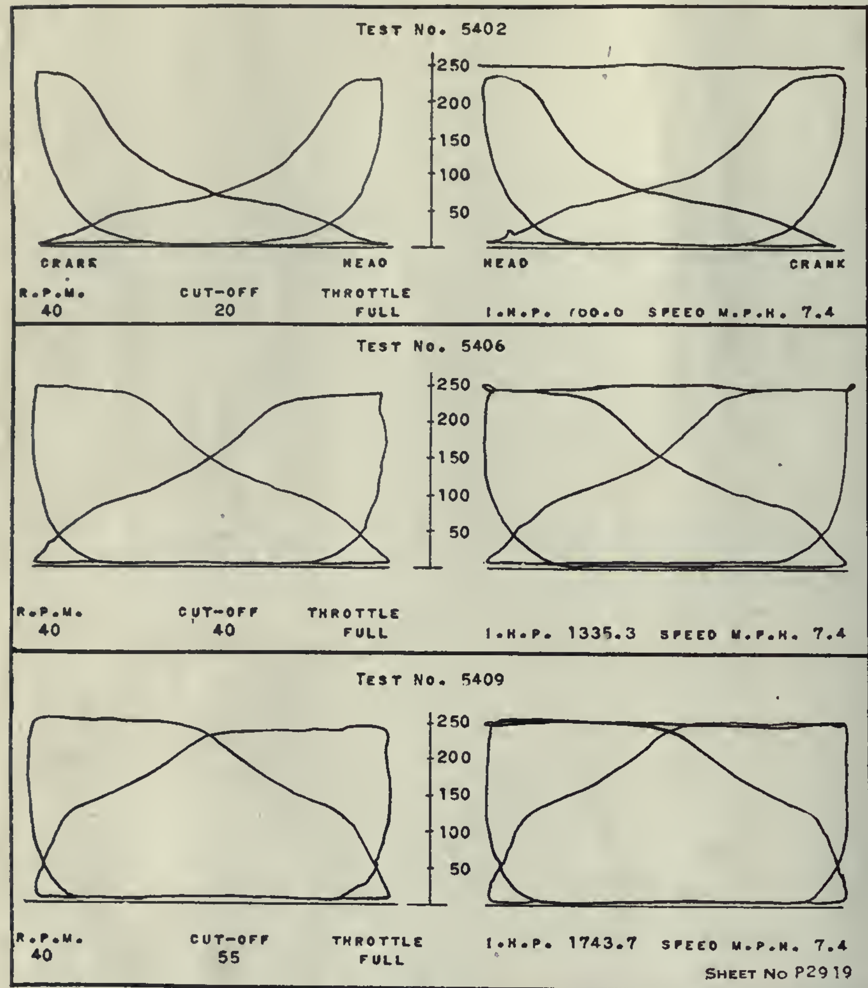
Again, instead of the steam consumption per indicated horsepower, take the diagrams of steam consumption per dynamometer horsepower hour, and the same results are developed. Starting with a consumption of 25.8 lbs. for the decapod and 27.6 lbs. of steam per dynamometer horsepower hour at 700 horsepower, we have 18.4 lbs. for the decapod and 23.0 lbs. for the Mikado at 2,700 horsepower, with a minimum consumption of 18.0 lbs. for the decapod at 2,000 horsepower.

By comparing the two figures of 15.4 lbs. for indicated and 18.0 lbs. for dynamometer horsepower at practically the same power development, it appears that the internal resistance of the engine absorbs about 15 per cent. of the indicated horsepower when working at maximum efficiency.



COMPARATIVE DIAGRAM OF INDICATED HORSEPOWER AND STEAM CONSUMPTION FOR I1S AND L1S LOCOMOTIVES.

But the principal interest centers about



INDICATOR DIAGRAM, CLASS I1S TYPE LOCOMOTIVE.

the tables of water consumption per indicated horsepower. Of this, three tables are presented: The Water Rates at All Cut-Offs, for the two engines separately, and a third, The Comparison of Water Rates and Indicated Horsepower of the L1s and I1s Locomotives, in which the steam consumption, with the speeds indicated thereon of the two engines, are superimposed over each other.

These tables show the steam consumption at different points of cut-off for the varying indicator horsepower developed, not only for the continuous increase of horsepower for each point of cut-off, but also for the different speeds at which the engines were run. These tables are deserving of the most careful study.

Take the matter of speed first. At 40 revolutions per minute the Mikado could only develop 1,320 horsepower on full gear, with a steam consumption of 31.6 lbs. per hour, while with a 75 per cent. cut-off it developed 1,300 horsepower on a steam consumption of about 25 lbs. per hour. This made it possible for the engineer to throw away 25 per cent. of the necessary steam with no results. The best results at 40 revolutions per minute with the Mikado were obtained when developing 1,000 horsepower on a 50 per cent. cut-off and a steam consumption of 21.7 lbs. per hour, as shown on the diagram.

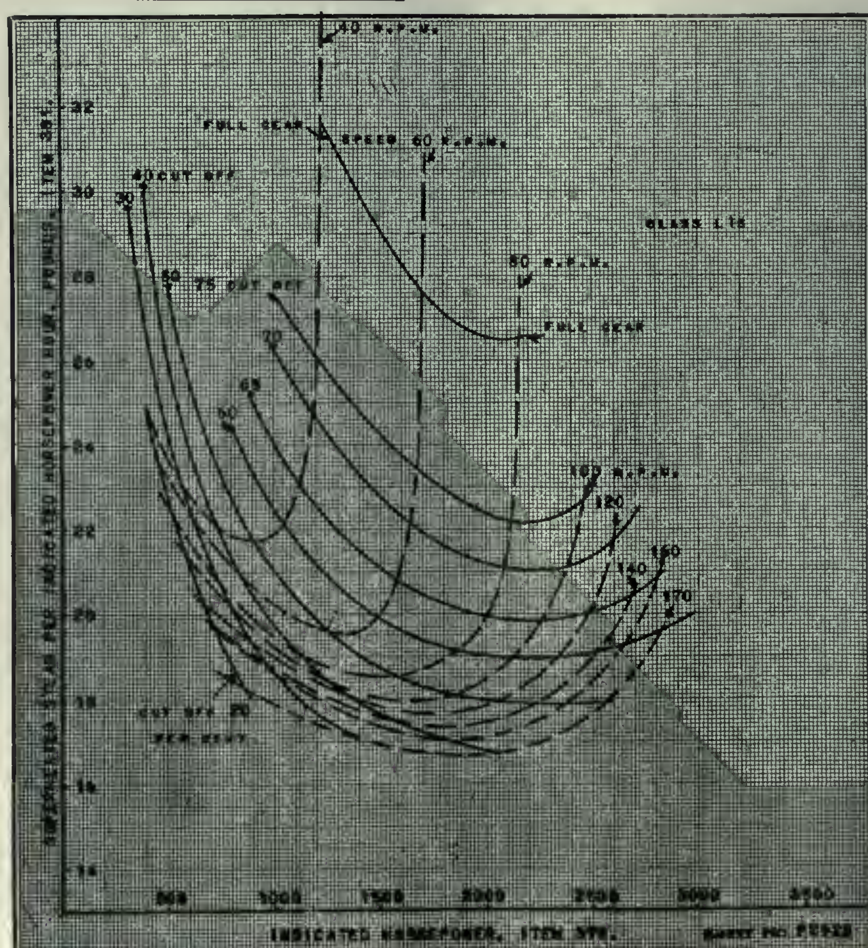
Now compare this with the decapod. At a cut-off of 55 per cent., and 40 revolutions per minute, the engine developed 1,840 horsepower on a steam consumption of 19.6 lbs. per horsepower hour, while if we drop back to 1,200 horsepower we find it to have been developed with a 35 per cent. cut-off on a steam consumption of 19.2 lbs. per hour.

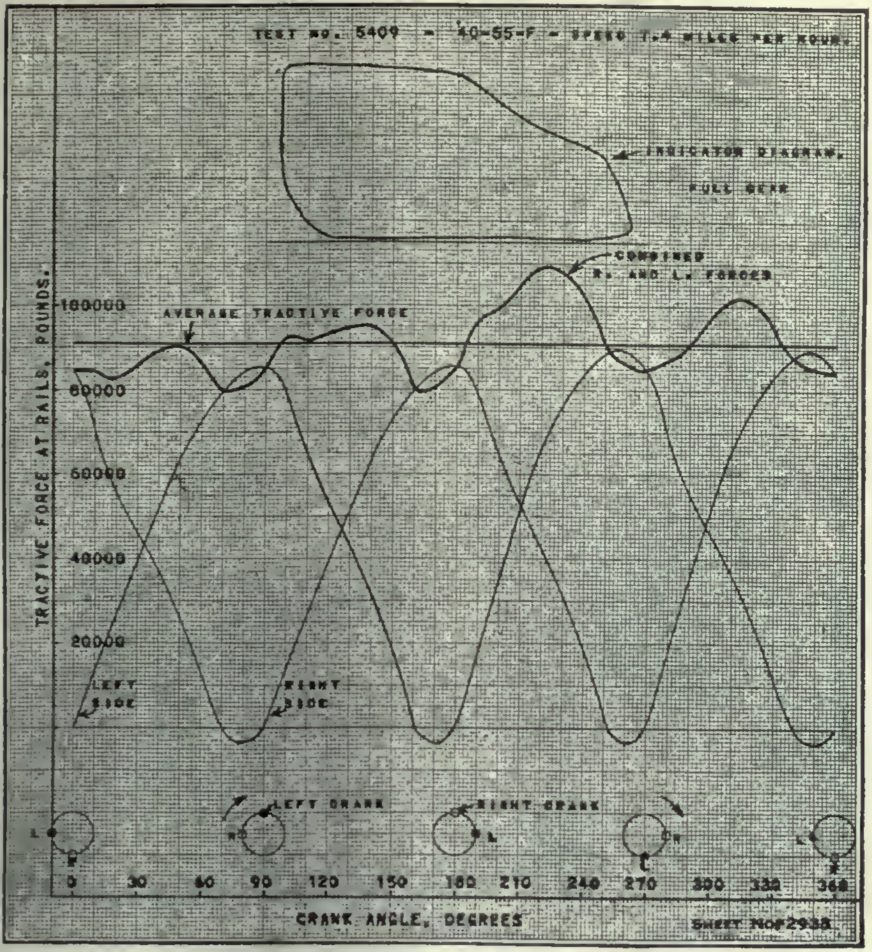
Here, then, at a speed of 7.4 miles per hour we have a possible increase of power development of nearly 42 per cent. on about 47 per cent. less steam, or an increase of 42 per cent. in horsepower on about 15.5 per cent. less total steam consumption. This, with both engines in full gear, but one cutting off at 55 per cent.

Now move to the other end of the table and note the maximum horsepower developed at the maximum speeds. The Mikado's maximum was about 2,900 horsepower at 160 and 170 revolutions per minute (29.6 and 31.5 miles per hour, respectively). The decapod developed 3,700 horsepower at 140 revolutions per minute.

At 140 revolutions per minute the Mikado developed a maximum horsepower of 2,800 on a steam consumption of 20.5 lbs. per horsepower hour, with a cut-off

BELOW IS DIAGRAM OF WATER RATES AT ALL CUT-OFFS L1S TYPE LOCOMOTIVES.





TRACTIVE FORCE CURVES, FULL GEAR, I1S LOCOMOTIVES. CYLINDERS 30½ X 32 INS., STEAM PRESSURE 250 LBS.

of 65 per cent. The decapod developed 3,700 horsepower at 50 per cent. cut-off on a steam consumption of 16.9 lbs. per indicated horsepower. Here again we have an increase of 32 per cent. in horsepower, with a decrease of about 20 per cent. in steam consumption. If we check the Mikado's performance on a 50 per cent. cut-off, it becomes 2,320 horsepower on a steam consumption of 15.9 lbs. per horsepower hour, or 1 lb. less than the decapod, but with a sacrifice of 1,380 horsepower to effect the relative saving.

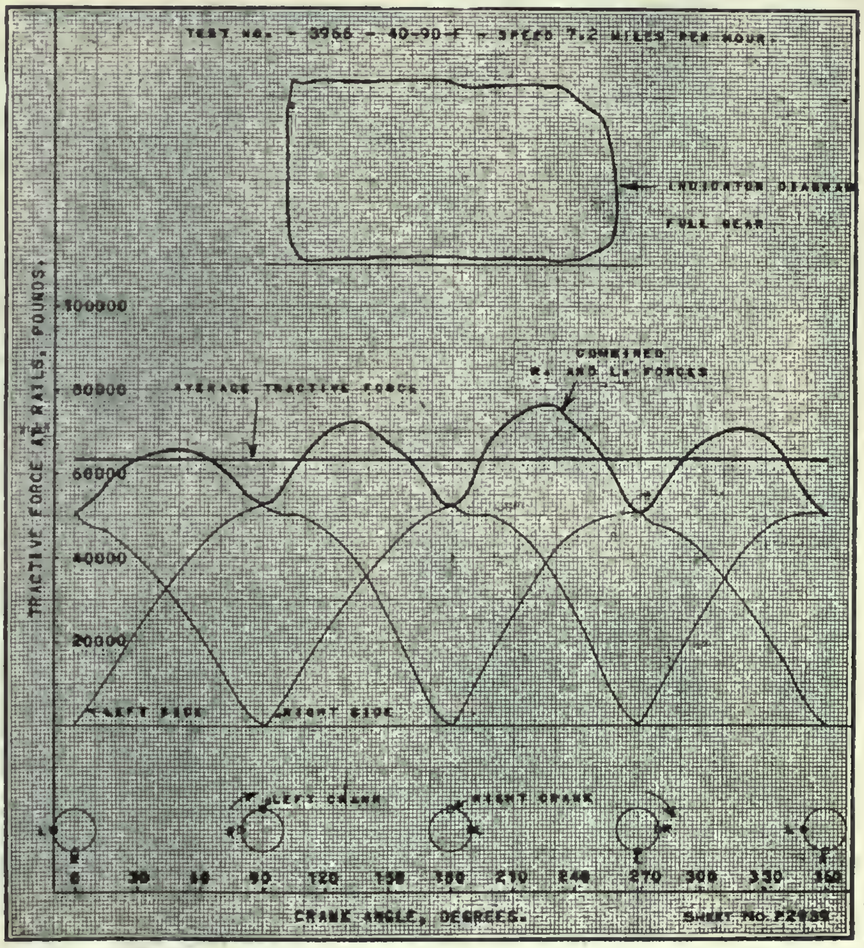
These are but a few of the interesting items that may be developed from these tables, which should be most carefully studied.

Finally, two diagrams of the turning moments of the two engines are given in the Tractive Force Curves for Full Gear. These show that in the case of the decapod (I1s) cutting off at half-stroke, the turning moment forms nearly as smooth a curve as for the Mikado (L1s) cutting off at nearly full stroke, and therefore that the advantages of a favorable cut-off are obtained in this locomotive, without introducing high peaks in the curve, or any unusual tendency towards the slipping of the driving wheels.

Tests were also made of this engine with a duplex stoker, which will be discussed in a future article. It may be added that the I1s type has proven itself, and there are now 122 of them in service.

It is not necessary to recapitulate the data furnished in this remarkable test, as those interested will note the significance of each item separately,—all of value in arriving at a conclusion. In the important item of steam economy, which means fuel economy, it might be emphasized that as shown in the records, the Decapod locomotive developing 2,900 horse-power used 15.6 lbs. of superheated steam per horsepower hour, whereas the Mikado locomotive developing the same power, 20.2 lbs., showing a saving of 33 per cent in favor of the Decapod locomotive. In this connection we should remember that recent tests on stationary engines equipped with the Corliss gear showed a consumption of 16 lbs., the Corliss engine, as is well known, not being adapted to locomotive service, need not be referred to, only as showing that the Decapod as tested shows a degree of economy equal to that of any engine moved by steam pressure.

BELOW IS DIAGRAM OF TRACTIVE FORCE CURVES, FULL GEAR. CLASS L1S LOCOMOTIVES, CYLINDERS 27 X 30 INS., STEAM PRESSURE 205 LBS.



Locomotive Designing

By P. W. Kiefer, New York

The abstract of paper by Mr. W. A. Austin, entitled "Locomotive Designing," which was published in the December, 1919, issue of RAILWAY AND LOCOMOTIVE ENGINEERING, excited my keen interest.

The principles outlined therein have been used by another of our great American locomotive builders for some years. The fact that the general proportions of the U. S. R. A. six-wheel switcher may be analyzed and accounted for in the manner described was especially interesting, and I am wondering if the proportions of this and the other types of simple locomotives designed and built at the instance of the U. S. R. A. were actually determined upon by means of these basic principles, it being understood that certain variations are to be expected, due to the limits imposed by weights and clearances, and that a detailed study of boiler proportions and heating surface values was no doubt made.

The designing and proportioning of the four-cylinder Mallet compound is a related subject, which, I believe, is of vital interest to many readers of RAILWAY AND LOCOMOTIVE ENGINEERING, and one which, thus far, has been passed over all too briefly by our current mechanical periodicals.

The methods used in designing the U. S. R. A. Mallet compounds, in which the best minds among our foremost American builders were no doubt concerned, should afford excellent data upon which to base a study of this important motive power unit.

Toward this end I desire to present for consideration certain features of this problem. For our purpose, let:

C = dia. high pressure cyls. in inches.
c = dia. low pressure cyls. in inches.
S = stroke in inches.
P = boiler pressure in pounds.
D = dia. driving wheels in inches.
H = max. m.e.p. in high pressure cyls.
E = max. m.e.p. in low pressure cyls.
R = ratio of cyl. volumes.
K = a constant.
TE = tractive effort working compound at max. cut-off and slow speed.

Assuming that equal amounts of power are developed by the high and low pressure engines, the total tractive effort developed by Mallet compounds may be calculated by either of the following recognized formulæ:

$$\text{(a)}\quad TE = \frac{c^2 \times S \times 1.7\ P}{(R + 1)\ D}$$

$$\text{(b)}\quad TE = \frac{c^2 \times S \times K \times P}{D}$$

Analyzing formula (a) we find that it is based on a *total* m.e.p. equal to 85 per cent boiler pressure. In formula (b) constant "K" equals .52 when cylinder ratio is 2½ to 1, and the high pressure engine "cuts off" at 84 per cent stroke.

Constant "K" is varied as follows:

Decreased for higher cylinder ratios and same high pressure engine cut-off.
Increased for lower cylinder ratios and same high pressure engine cut-off.
Decreased for shorter high pressure engine "cut-offs" and same cylinder ratio.
Increased for larger high pressure engine "cut-offs" and same cylinder ratio.

Analysis shows that when "K" .52 the *total* m.e.p. 91 per cent boiler pressure. There appears to be no good reason why the percentage of boiler pressure (total m.e.p.) available at slow speeds and full cut-offs in the cylinders of a four-cylinder compound should be greater than that available in the cylinders of a simple engine, in fact, it seems reasonable to assume that in the case of the four-cylinder compound it would be less, and as this pressure for simple engines is generally conceded to be around 85 per cent boiler pressure the use of formula (a) in preference to formula (b) seems justifiable.

For any two-cylinder simple locomotive:

$$\text{(c)}\quad TE = \frac{C^2 \times S \times H}{D}$$

Either mathematical or graphical methods may be used to prove to anyone's satisfaction that this formula is correct. It follows that if we consider the Mallet compound as two separate engines, the tractive effort formula may be written:

$$\text{(d)}\quad TE = \frac{C^2 \times S \times H}{D} + \frac{c^2 \times S \times E}{D}$$

Assumed that $H + E = .85\ P$

$$\text{Now } H = \frac{.85\ PR}{(R+1)} \text{ and } E = \frac{.85\ P}{(R+1)}$$

Substituting these values for "H" and "E" in (d) we have:

$$\text{(e)}\quad TE = \frac{C^2 \times S \times .85 P \times R}{(R+1)\ D} + \frac{c^2 \times S \times .85 P}{(R+1)\ D}$$

The "mean effective" pressure curve presented in Mr. Austin's paper, which shows the drop in pressure in cylinders of simple locomotives as the piston speed increases is, in the main, very similar to the curve used for the same purpose by the locomotive builder referred to above. The writer has had occasion to develop drawbar-pull-speed curves by means of the dynamometer car which, at working speeds, were found to closely approximate those calculated by the aid of the "mean effective" pressure curve, the calculated curves having been corrected for the various resistances.

If we had data indicating the drop in m.e.p. occurring in the high and low pressure cylinders of Mallet compounds as the piston speed increased, or assuming that equal power is developed by each pair of cylinders, if reliable data was at hand showing this pressure drop in the high pressure cylinders only, the decreasing values of "H" and "E" could be substituted in formula (d) for the purpose of calculating the cylinder tractive effort curve, from which the construction of the cylinder power curve would follow, and the amounts of steam required per hour at various speeds for different combinations of cylinder diameters, strokes and ratios could thereby be predicted. This information would provide the designer with a basis upon which to determine boiler proportions and grate areas.

The tabulation below is presented for the purpose of illustrating the effects on tractive effort of changes in cylinder ratios.

Having given a 2-8-8-2 Mallet compound, cylinders 24½-inch and 39-inch by 32-inch, diameter driving wheels 56-inch, and boiler pressure 230 lbs.

	Cylinder Ratio		Cyl. Dia.		*Max. M.E.P.		Total Tractive Effort.
Case.	Ratio.	Change.	H.P.	L.P.	H.P.	L.P.	Lbs.
1	2.534	None	24.5"	39"	140.2	55.3	96,163
2	2.8	Increased by increasing dia. L.P. cycls.	24.5"	41"	144.5	51.447	98,827
3	2.8	Increased by decreasing dia. H.P. cycls.	23.307"	39"	144.5	51.447	89,430
4	2.2	Decreased by decreasing dia. L.P. cycls.	24.5"	36.34"	134.4	61.09	92,199
5	2.2	Decreased by increasing dia. H.P. cycls.	26.29"	39"	134.4	61.09	106,177

**Total* max. M.E.P. assumed to be 85 per cent boiler pressure.

New Locomotives for the South African Railway

While it is true that locomotives built in accordance with American practice have demonstrated their fitness for service in all parts of the world, there are many railways which, for good and sufficient reasons, when purchasing locomotives from builders in the United States, specify that European designs be followed. The Baldwin Locomotive Works has had considerable experience in work of this kind, even to the extent of building locomotives throughout to the metric system of measurement. Notable among these were the Mikado type locomotives for the Paris, Lyons and Mediterranean Railway and the Nord Railway of France, and the Pechot type locomotives for the French Government, all of which were constructed during the war period.

Among the most interesting of these locomotives were thirty for the South African Railways, built throughout in accordance with the railways' designs and specifications. The South African lines are built to a gauge of 3 ft. 6 in., and in view of the narrow gauge and clearance limits, the motive power is conspicuous because of its exceptional weight and capacity. The new locomotives are of the 4-8-2 type, and the average weight carried per pair of coupled wheels is very nearly 38,000 pounds. The tractive force, assuming a mean effective pressure on the pistons of 85 per cent. boiler pressure, is 41,700 pounds, which is comparatively high in proportion to the weight on the coupled wheels.

Locomotives of this general design have been in service on the South African Railways for some time, working between the Withank Coal Fields and Johannesburg, hauling trains of 1,400 tons over this 80-mile stretch of track, the maximum grades being 1 in 100. The locomotives are designed to traverse curves of 300 feet radius.

The new Baldwin engines have straight top boilers, with wide fire-boxes of the Belpaire type. The inside firebox plates are of copper, a material which has given excellent service results in this district, where the water used is of exceptionally poor quality. A fire-tube superheater is installed, and the steam temperatures are indicated by an electric pyrometer. The boiler accessories include a power-operated grate shake.

The steam distribution is controlled by piston valves 11 inches in diameter, which are operated by Walschaerts motion. The gears are controlled by the Ragonnet power reverse mechanism.

VIEW OF BOILER HEAD AND ATTACHMENTS.

The frames are of the plate type; and it is interesting to note that they were shipped completely assembled with cross-ties, cylinder saddle, cylinders, guides and guide yoke. The pistons were in the cylinders, and the cross-heads in the guides. This type of sub-assembly makes for convenience in the final erection.

The equipment of these locomotives includes American steam brakes on the coupled wheels, automatic vacuum brakes on the tender, with train connections, and Hasler speed recorders.

These locomotives rank among the largest non-articulated engines of 3 ft. 6 in. gauge thus far built, and they are an interesting example of the capacity that can be obtained in a narrow gauge locomotive. Further particulars are given in the following table of dimensions:

Gauge, 3 ft. 6 ins.

Cylinders, 22½ ins. x 26 ins.

Valves.—Piston, 11 ins. diam.

Boiler.—Type, straight top; diameter, 69 ins.; Thickness of sheets, ¾ in.; working pressure, 190 lbs.; fuel, soft coal; staying, Belpaire.

Fire Box.—Material, copper; length, 88 ins.; width, 65⅛ ins.; depth, front, 76¾ ins.; depth back, 54¾ ins.; thickness of sheets, sides, 9/16 in.; thickness of sheets, back, 9/16 in.; thickness of sheets, crown, 9/16 in.; thickness of sheets, tube, 9/16 in. and 1 in.

Water Space.—Front, 3 ins.; sides, 3 ins.; back, 3 ins.

Tubes.—Diameter, 5½ ins. x 2¼ ins.; material, steel; thickness, No. 9 W. G., No. 11 W. G.; number, 24, 139; length, 20 ft. 1⅞ ins.; 20 ft. 1⅞ ins.

Heating Surface.—Fire box, 158 sq. ft.; tubes, 2338 sq. ft.; total, 2496 sq. ft.; superheater, 532 sq. ft.; grate area, 39.9 sq. ft.

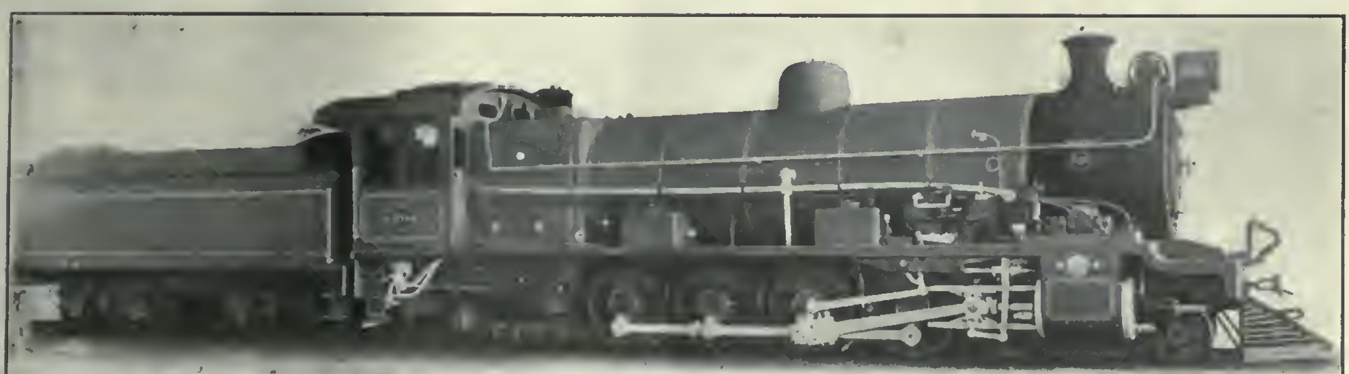
Driving Wheels.—Diameter, outside, 51 ins.; diameter, center, 45 ins.; journals, main, 9 ins. x 10½ ins.; journals, others, 8½ ins. x 10½ ins.

Engine Truck Wheels.—Diameter, front, 28½ ins.; journals, 5½ ins. x 8½ ins.; diameter, back, 33 ins.; journals, 5½ ins. x 11 ins.

Wheel Base.—Driving, 13 ft. 6 ins.; rigid, 13 ft. 6 ins.; total engine, 31 ft. 9½ ins.; total engine and tender, 57 ft. 7⅜ ins.

Weight.—On driving wheels, 151,900 lbs.; on truck, front, 27,200 lbs.; on truck, back, 26,000 lbs.; total engine, 205,100 lbs.; total engine and tender, 310,000 lbs.

Tender.—Wheels, number, 8; wheels, diameter, 33½ ins.; journals, 5½ ins. x 10⅛ ins.; tank capacity, 5100 U. S. gals.; fuel capacity, 8 tons; service, freight.



NARROW GAUGE TYPE LOCOMOTIVE FOR THE SOUTH AFRICAN RAILWAY. BALDWIN LOCOMOTIVE WORKS, BUILDERS.

The Railroad Problem

Essentials to Development and Prosperity

We took occasion last month to make extracts from an address by Mr. Hines, who has been acting as Director General of Railroads since the resignation of Mr. McAdoo, and while we could not endorse many of his conclusions, it is only proper that a fair hearing should be given to all who are in a position to have a wide vision of the railroad problem. It is fair to assume that the Government, including the members of the various commissions, both Federal and State, have learned lessons that they will not soon forget, and it is to be hoped that the experience gained will blossom into a more generous spirit in dealing with the real needs of the railroads, not only in maintaining the equipment necessary to safe and speedy transportation, but also to the continued extension and development of the railroads into new territories, and above all to a reasonable return for the use of the invested capital without which we would still be in the trackless wilderness.

In this regard it will be admitted that the champions of private ownership with governmental supervision have done great work in the advocacy of their views. The fine temper shown by all of the leading railroad men under the most trying and, in many instances, under the most provoking insinuations as to honesty of purpose has been admirable, and among those who have ably and eloquently maintained the rights of the owners of the railroads none have spoken more fully and fairly than Samuel Rea, President of the Pennsylvania railroad system. In an address delivered before the Real Estate Board of Detroit, on January 15, 1920, Mr. Rea pointed out that the greater number of our institutions and private citizens who provided the moneys for the construction of the railroads are not rich, and depend upon fair returns on their railroad investment as one of the means of living. If that return is too low, or is cut off, or the authorities are unfair in legislation or regulation, the new capital cannot be obtained for railroad betterment and new construction.

After the return of the railroads the public cannot expect that the roads will be immediately working smoothly, nor that all of the special conditions essential will be adjusted to meet all expectations. That will come gradually from skilled supervision and the settlement of unrest that affects the country at large. The release of the railroads from Federal control is desirable, but their abandonment by the Government without proper business and legislative precautions would be a calamity, especially as their revenues have not been adjusted to present costs.

Mr. Rea is of the opinion that the immediate railroad essentials—and they are equally important to business and finance —are these:

1. Adequate rates to be at all times maintained to prevent the railroads from again getting into the weak position from which they are now trying to emerge. For this purpose the adoption of a rate-making rule, or, if that is not acceptable, the fixing of some minimum return is essential for the positive guidance of the Commissions which regulate rates, and it should be on a fair average basis of return throughout a series of years.

2. Fund the War indebtedness to the Government, which chiefly consists of expenditures made by the Government for additions and betterments essential to carry the traffic of the War period and protect the life of the Nation; and also return the roads with sufficient working capital to resume operations. The Government found it essential to have working capital, and the railroads were called upon to provide a large part of that working capital, at the beginning of Federal control, both in money and materials and supplies.

3. Continue the standard compensation as prescribed by the Federal Control Act and Contract for at least six months, until the railroad situation has been steadied by adequate rates and stronger credit.

4. Provide sufficient capital to finish additions, betterments, and equipment already authorized by the United States Railroad Administration, as well as to finance additional new work and equipment that should be authorized in 1920, and enable the railroads to provide for securities maturing in that year.

The Government is not asked to make a gift to the railroads by such finding of past expenditures or for such new capital, but to advance the same and bridge over the difficult financial period, receiving from the railroads the best securities they can afford to evidence such debts, and require their payment in, say, ten years, with suitable interest. Otherwise new equipment and facilities cannot be provided in 1920. We must prevent restriction of business from inadequate facilities to accommodate the expanding business of the country; we must see that labor will be justly dealt with, and the investors may have the basis upon which, by vigilant management and efficient operation, a proper return can be paid on the existing railroad investment and a fair margin earned to induce the new capital to invest in the roads. If the legislation is not of this character then we will have stagnated railroad systems, which will cripple industrial enterprise, curtail production, increase transportation costs and may ultimately compel Government ownership and operation.

The difficulties the railroads have had to contend with would not be of moment today if the railroads had received in the past ten years rates at all commensurate with the investment. That service was not only the cheapest, but the best transportation everywhere. Fair wages were paid and the prosperity of the railroads was shared with the employees, and the Government received increased taxes. Nevertheless the position of the railroad investor was slowly but surely becoming weaker, not only through the reduction or passing of dividends, but through the loss of the purchasing power of the income. While our regulating authorities may have had good intentions, the net operating income was smaller than demanded in the public interest and entirely inadequate as a credit basis.

The compensation to be paid during Federal control was equal to a return on property investment of all the railroads of the country of 5.22 per cent, but the net operating return for 1919 on the property investment was about 3 per cent, due to non-restoration of the equilibrium between income and expenses. None of these returns are adequate in the public interest, or as a basis for credit, and if the national regulatory body does not change this condition, there is no escape from inadequate railroad facilities, poor service and restricted investment.

We are told that if this situation is equitably dealt with by adequate rates the strong railroads will get too much, and the weak railroads not enough. The railroads in 1900 had outstanding two hundred millions more stock than debt; now they have over two and a quarter billions more debt than capital stock. Instead of relieving this critical credit condition by adequate returns, they receive homilies on expected future economies and increased business, without any assurance of what the future will be. In the past these suggestions have proven to be delusions, and the railroads are too weak to exist in future on any such slender threads.

They are also constantly accused of watered capital, and a swollen property investment account. This delusion has not yet been buried. Have we forgotten the past with its many millions of good and poor railroad capital wiped out through reorganizations, or failure to earn dividends or interest, or the millions spent by solvent roads prior to

1907 out of surplus without any legal compulsion, for which not a dollar of securities were issued? Look at the Pennsylvania System with over five hundred million dollars of property and assets in excess of its capitalization. That is the result of 75 years of prudent financing. Can there be any doubt today that the real property investment for all the railroads exceeds their original cost or their capitalized cost, and that the property investment as stated is materially below its present actual value?

In fact the question of watered securities or swollen values has been further corrected, Mr. Rea stated, by four substantial factors:

1. On December 31, 1917, the par value of the Outstanding Capital Stock and Funded Debt of all the railroads, said to contain billions of water, was $21,249,357,241. Against that capitalization their gross investment, including road and equipment, miscellaneous physical property, investments in affiliated companies, and other general investments, aggregated, as shown in the Interstate Commerce Commission Report for 1917, $24,281,550,363, so that their total investment was $3,032,193,122 in excess of their total capital issues.

The companies also had a large amount in cash and materials and supplies as working capital in excess of their current liabilities, but for the present I have omitted this for good measure, so that I might be sure not to overstate the case, which is that the railroad property investment exceeds by at least Three Billions Dollars the outstanding railroad capital held by the public, and by the railroads.

The railroad companies themselves acquired and held $4,847,571,224 of that outstanding capital, and the balance, $16,401,786,017, was held by the public.

2. Let us look further at the question of capitalization from the income standpoint, and ask, Is the public fully supporting it? There we see that over 36 per cent of the total outstanding capital stock of all the railroads, or $3,250,000,000, does not pay dividends, and a very large part of that non-dividend paying stock is owned by the public, and an examination of the figures will show that the percentage of non-dividend paying stock instead of decreasing has been increasing in the connection with any feature of capital issues or investments of any kind.

4. In 1907, the railroads of the country had a total track mileage of 327.975, the property investment account represented by road and equipment was approximately $13,030,000,000, or an average per mile of about $39,730. That amount also included terminals, stations, yards, land, 55,388 locomotives, 1,991,557 freight cars and 43,973 passenger cars. That is the lowest construction cost in the world, and considering our higher rates of pay compared with other countries, is of itself a quick answer to the question of both an overstated property investment account and watered capital. But beyond that we know that $39,730 a mile of track would not take us very far in the present day costs. A mile of track requires right of way, grading, track, switches, signals, bridges, and other appliances, but when we also consider that the $39,730 per mile includes as well the cost of all of the big terminals, station and yard structures, locomotives, freight and passenger cars, then existing, we have a further assurance that now instead of the property investment being overstated as some have claimed by eight billions, the facts are that it is now understated by that amount.

In the meantime it is well to point out that the railroads of the country show a remarkable advance in efficiency by the growth of the train load, the car load, and in public service generally, but the owners who furnished the money have never been allowed to participate sufficiently in the prosperity of the country at large, of which they are one of the chief instruments.

The claim cannot be endorsed that to deal adequately with the railroads in the matter of rates will further increase the cost of living, or be an excuse for profiteering. Compared with the value of the article transported and the total profit earned on such products, transportation costs have been very low, and any adjustment essential to bring the railroads to a proper self-sustaining condition, and take them from the backs of the taxpayers and the public Treasury will be equitable to the entire country. The increase necessary to do so will be very small, compared to the rate increase that must be made on the railroads of any other nation with which this country competes in its trade and commerce. The fact remains that with better facilities, we can do an increased business and secure increased production and efficiency, and this is better for the country as a whole than congested traffic, decreased output, and lower wages, and the total stoppage of new railroad mileage in our country which is yet far from final development. Working and saving mean prosperity, but the railroads can never work efficiently nor at the lowest costs with a deficient plant, deficient revenues, nor insure the continued development of our vast mineral and manufacturing resources.

The taxation bodies have protected themselves by large increases, labor has insisted upon and received its share, higher prices for materials of all kinds have had to be met by the railroads during Government control, but without a corresponding adjustment of rates to that higher basis of costs, nor their returns to a common-sense basis of attracting new capital into the business, which must be attracted from the investors and cannot be commandeered. It is imperatively necessary that these adjustments be made if we are to restore the credit of the railroads and again have progressive, efficient, growing systems of transportation, equal to the needs of our advancing commerce, industry and agriculture.

Railroad Construction in Alaska

The two principal railroads in Alaska were, and are, the Alaska Northern Railroad and the Copper River & North Western Railway. Both lines extend into the mountains to the north. This is particularly the case with the present route of the former road. Its objective is Fairbanks, a town or city in the very heart of the Yukon Valley and 471 miles to the north of the southern tidewater terminus.

The highest elevation is at Broad Pass where the route rises to an elevation of 2,319 feet. The distance from the terminus to the south is at this point 314 miles, leaving only 157 miles for the descent to Fairbanks. This road when completed will put the great region on the north side of the Alaskan Range into real communication with the district on the south side.

The Alaska Northern Railroad is the road known now as the Government Railroad. It was formerly operated as a privately owned enterprise. In those days, the maximum length amounted only to about 71 miles. The Government has thus undertaken some 400 miles of construction. The participation of the Government is now only a few years old. The route was formally announced by President Wilson on April 10, 1915. The southern terminus is at Seward at the head of an indentation of the coast known as Resurrection Bay. The old railroad, 71 miles long, including presumably any further work that had been done, was to be purchased for $1,150,000. It was expected that $26,800,000 would be expended on construction, including the branch into the Matanuska Coal Fields. Possibly this included an allowance for rolling stock and other equipment. A good deal of material has been transported from the Panama Canal to Alaska for the use of the road. The distances which it is necessary to transport rails, construction equipment and other supplies are great. There is probably little or nothing to come back as a return cargo. The period during the year when construction can go on actively is short.

The starting point of the railroad at Seward is on the Kenai Peninsula. This is a considerable piece of land which is really almost cut in two by arms of the sea on the east and west. It is at the head of the Gulf of Alaska, but somewhat to the west. The route cuts across the peninsula from the south and then skirts the coast for a very considerable total distance on the west side. In fact, when at last the road strikes inland and bids farewell to tidewater, it has already covered about one-third of the distance to Fairbanks.

There are 5,000 or 6,000 population at this point. This is Anchorage. It may be reached by water by sailing round the west side of the peninsula. It forms a kind of second terminus for the southern part of the railroad. During the season of the year when the water route to Anchorage is available, it may very well be that Seward will sink to second place. The route by rail from Fairbanks will thus be cut something like a third. And what is quite important, the rail route from the Matanuska Coal Fields to tidewater will be very greatly shortened.

Here at Anchorage the Government is constructing a port. Two moles are to run out from the shore like long arms. These will incline towards each other. Their outer ends are to be connected by a great wharf 1,000 feet long. The mole on the north is to be wide enough on top to carry three standard-gage railway tracks. The construction of the wharf and appurtenances has to take into account some unusual features. When the problems raised by conditions are fully met, the railroad will have a very good and efficient tidewater terminal much closer to Fairbanks and the coal fields than Seward. One of the problems that has to be solved at Anchorage is connected with the enormous tides. The maximum tidal change runs up to about 42 feet. This means that a ship alongside the wharf may be 42 feet higher than at another time. The wharf front must be a wall tall enough to rise above the highest tide and deep enough to have, say, 30 or 40 feet of water in front of it when the lowest tide level is reached.

It will be readily understood, perhaps, after consideration of the 42 feet of tidal difference, that loading and unloading will not always occur under the same conditions. Whatever crane or the like is installed to put on and take off freight should be of the kind that can make the 42-foot change in its vertical reach. The grab bucket is very well suited to great changes in the level to which it must be lowered. We may, when we visit Anchorage, expect to see Matanuska coal put on board ships by this device. Naturally, the harbor works have to be constructed during the short favorable season.

The route of the railway from Seward to Fairbanks is, in general, a northerly one. But there are, naturally, deviations at various points. After the road has cut across the Kenai Peninsula from Seward, it strikes the inner end of an extension of Cook Inlet called Turnagain Arm. The route runs along the northern shore of this body of salt water and then follows the southeastern shore of a second extension, this one called Knik Arm. In short, there is a very considerable fraction of the total mileage located along tidewater shores.

BRIDGE—ALASKA RAILROAD.

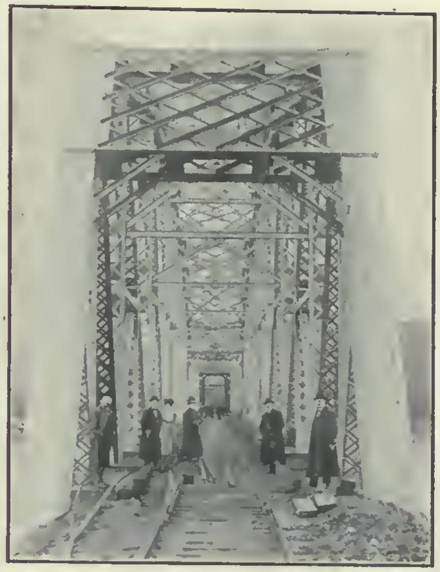
The winter before last was productive of trouble. In a section about half-way between Seward and Fairbanks, there was at many places 2½ feet of snow as late as April. In fact, section-men could not push north from this region until in June. At Indian River, near Broad Pass, there was, in April, 5 feet of snow. It will be understood that the accumulations of snow are either going to slide or melt. In either case, a good deal of trouble may ensue. For example, further north, on the far side of the mountains, the Nenana River bed received more flood than it could transmit. The stream left the channel and broke through Lost Slough, flooded completed grade and created several kinds of trouble. That the engineers were surprised by the extent of the flooded area is indicated by the fact that they re-located the line 2½ miles to the east. In fact, a good deal of work has to be done with incomplete information. It takes time to learn what a river is capable of, given a fair opportunity.

NEW SHOPS RECENTLY COMPLETED ON THE ALASKA RAILROAD.

There are two considerable coal fields tapped by the railroad. One is the Matanuska and the other the Nenana. The former lies on the southern side of the great range; the latter on the northern side. In fact, the Matanuska Coal Beds are only a few miles inland from the tidewater shores of Turnagain Arm and Knik Arm. A branch line and a spur from the branch penetrate to the mines. The best of this coal is very high quality.

There is other good coal in Alaska, notably that in the region of the Bering River. This is only a short distance back from the shores of the Gulf of Alaska, but is considerably further east than Resurrection Bay and Seward. The Copper River & North Western Railway runs inland from Cordova and could perhaps be utilized, after some expenditures on necessary construction, to get this coal to open tide-water. The Copper River & North Western Railway is 195 miles long, and runs from Cordova, at tidewater, to Kennecott. This road is standard gage. This and the Government railroad are the two principal lines in Alaska.

The Government road from Seward to Fairbanks will measure when completed 471 miles. The old Alaska Northern is the southernmost end. The Government has been constructing north from this end and has also been constructing south from the other end of the line. A gap still remains. About June 30, 1919, the date of the Report of the Secretary of the Interior, this gap extended from mile 237 (from Seward) to mile 365. This



END VIEW OF BRIDGE ON ALASKA RAILROAD.

gap of 128 miles lies in the region where the road passes through the mountains from the southern slope to the northern one.

The branch line into the Matanuska Coal Fields leaves the main line at the station Matanuska, about 30 miles north of Anchorage, and is 37.7 miles long. The terminal is Chickaloon. The Government has, in addition to carrying on the construction work on the extension of the old Alaska Northern to Fairbanks and on the branch into the coal fields, acquired a narrow-gage road in the Fairbanks region. This is 45 miles long and is called the Tanana Valley Railroad.

Besides the two considerable lines already described or mentioned, and the narrow gage Tanana Valley railroad, there are several short railway lines in Alaska. Thus, there is the White Pass & Yukon road, 20 miles of which lie in United States territory and the remaining 92 in Canadian. This is a narrow-gage affair. There are several other roads or pieces of road in Alaska. Altogether, there is right now about 600 miles of line.

In addition to its coal, copper and gold, Alaska is already developing its resources in respect to tin, antimony, silver, tungsten and chromite. Oil has been found, and it is probable that the country will also produce zinc, platinum, quicksilver, graphite, asbestos and other minerals. So the railroads will have something to haul to the coast in the course of a few years.

Snap Shots

By the Wanderer

A short time ago a great flourish of trumpets accompanied a marked reduction of weight of freight cars on the X. Y. Z. railway. The reason for the reduction is that under a former superintendent of motive power the cars were built very heavy so as to be able to keep them out of the shop. That is, the weight for a 100,000 lbs. gondola averaged about 46,000 lbs., hence the desire to reduce them to 38,000 to 40,000. In this there is sometimes a contest between the motive power and traffic departments in that the former wants to increase weight and strength in order to keep the cars out of the shop, whereas the latter looks to cutting down weight in order to reduce hauling expenses. The articles that were published in an engineering journal last spring on defective box cars attracted a great deal of attention and have had an influence in inducing managements to incur a greater expense for new cars so as to get something that will better withstand the severe usage of service than the lighter cars heretofore in use. Builders are especially urgent that better end construction should be used so as to withstand the stresses imposed by shifting loads. And the better class of builders are of the opinion that it is always well for the railroads to furnish their own drawings for cars, because then they can attend to the end construction and be sure that it is all right, whereas if they trust to builders' designs they are apt to have a weak structure offered because it can be cheaply built.

In spite of the general tone of semi-optimistic content with which superintendents of motive power "acknowledge" that they are having no trouble with the lubrication of locomotives using a high degree of superheat, there seems to be a desire, on the part of most of them, "for something better than they had known." The fact is that if the question is put point blank to the roundhouse foreman who is in close touch with the lubrication of these engines as to whether the superheater oil used carbonizes, the answer, "Yes," will come back straight and clear. We are getting away from the low superheat and 650° Fahr. is becoming common practice; and 650° is a pretty high temperature for an oil to resist and maintain its or even a portion of its lubricating qualities. The struggle, then, is to get something better. What shall it be?

If I knew more about the financial status of the dining car I could either remain silent on the philosophical courtesy of declining to look a gift horse in the mouth or I could attempt to put some ginger into my remarks. But, as it is, I don't know whether I am an object of charity or am being imposed upon and am not getting my money's worth. It all depends on whether the dining car service pays or not. If it does not pay, then I apologize for my seeming discourtesy in criticizing a gift. If it does pay, then it seems to me that it is about time that there should be an awakening and an attempt to render an equitable *quid pro quo*. It seems to me that, when one pays from 50 to 200 per cent. more for an article of food on a moving restaurant than would be asked on a stationary one, there is a right to expect at least an equality of quality. A recent lunch on a first class trunk line affords my text, and the trouble was, it was not so bad that it gave a pretext for a direct complaint but was bad enough, unsatisfactory enough and expensive enough to make me feel that I was being imposed upon. My meat was not so tough that it could not be eaten, but it was poor and unattractive in quality, cooking and service. My potatoes were not hot nor cold, but were underdone and tasteless, and my chocolate was served at a temperature of about 90° Fahr. and was merely some diluted milk with the chill taken off, flavored with a delicate vanilla and colored, I suppose, with chocolate. Nothing very bad, and nothing that even resembled goodness, and yet the price was high even for those fashionable places where no one is expected to really eat. And now what I would like to know is whether I was the object of the railroad's charity or was I imposed upon?

When Mr. Ely of the Pennsylvania R. R. planned the bed and prepared the car to carry President Garfield from Washington to Elberon in 1881, he probably produced the easiest riding vehicle that has ever run over a railway. It was a peculiarity of the run that greater ease was obtained at high speeds than at low. Vibration was practically eliminated, and a degree of comfort obtained that is usually considered unattainable. But a close approach to this ideal condition is to be found in some of the steel sleepers turned out by the Pullman Company. Their ease of motion is truly remarkable when measured by the ordinary standards and the question arises, why cannot this be imitated in the ordinary steel passenger coach or parlor car? It hardly seems probable that it is purely a matter of weight. Springs do not always act the same even though they may calibrate the same and it seems as though it would be well worth while, certainly it would from the passengers' standpoint, to do more than test springs, but watch them in service. Certainly if sleeping cars can be made to ride as well as those referred to do, there is a possibility of a great improvement in other cars that run over the same rails, in the same trains.

I sometimes wonder if the classical saying of Lincoln about possibility of fooling all of the people some of the time, some of the people all of the time, and the impossibility of fooling all of the people all of the time, quite holds if "workmen," is substituted for "people." From the voluntary confessions of the men who are anxious to secure the labor vote, as well as those who have the labor support for purely tongue-work, it appears to the casual observer that there is mighty little sincerity in what is being done and advocated. The railroad representatives, for example are asked to withdraw opposition, or frame bills that will suit themselves, because, "you see, I'm down here to influence legislation, and I've got to get something through if I'm to hold my job. It doesn't much matter what it is, provided only I can go back and say I did it." Are the men really fooled or persuaded into thinking that all these measures are for their benefit, or are they simply dazed, bewildered by the volubility of their representatives, out-talked and so silenced that they have nothing to say? Are the practical locomotive engineers really fooled, when their voluble representative talks glibly of the great work that has been done in securing an electric headlight order on a boiler inspection bill? Don't they know that a high-power light is a farce and that a real genuine locomotive boiler explosion is an almost unknown quantity? Don't they know that the job created by these orders and bills will not go to the best men of their class, but to those that are apt to be more or less discredited? The rank and file of these men, taken individually are of a high order of intelligence, brave, faithful, contented and earnest, and it seems impossible to believe that they are really imposed upon by these pseudo professions. Do they really take stock in the wordy speeches of their representatives or do they submit to their domination because they feel that they must be represented and do not know how to go about to get what they ought to have and so submit from mere helplessness? I can't believe that they are really fooled.

At a recent meeting of a railroad club, there was a paper presented and a discussion following upon the uses of titanium for improving the character of the iron alloys, especially those of steel rails and cast iron wheels. Titanium is a scavenger, pure and simple and, as ordinarily used it forms no compounds with the iron and, in fact, is not to be found in the finished product. From what was said at this meeting, it seems that the wear of titanium rails is only about 35 per cent of that of the ordinary Bessemer rails of 55 per cent carbon; the others having 48 per cent. The use of titanium was also advocated for cast iron wheels, because it will produce a closer-grained metal and one free from blow-holes and, therefore, stronger in the rim and plates. To be sure, the percentage of free carbon is cut down while that of free graphite is increased. But this was said to result in a better wearing chill, though of less depth. These claims are worthy of investigation, for it is an admitted fact that titanium is a great scavenger and serves for the elimination of those deleterious bodies, the oxides and nitrites, from the steel. But it is certainly a revelation to be told, to quote from one speaker, to what extent wear in service is due to this point almost entirely.

It was also stated that the titanium treatment made steel much less liable to rust, and this is a direct confirmation of theory and past observation in other directions. But whether all of these valuable properties are the direct result of the titanium treatment remains to be proven by more exhaustive investigations than any that have, as yet, been made public.

An interesting case of back development comes from Norway, where, during the war, on account of a scarcity of coal, certain experiments were carried out on the State Railways in the burning of wood on locomotives. They went back to the old centrifugal type of spark catcher. Evidently wood did not make a satisfactory fuel. It required more work of the fireman, a fatal defect in these days of oil burners and mechanical stokers. It attacked the stack and cut holes in it in 10 months' time. But they found, what any good housewife could have told them, that only well dried wood should be used. The green wood, the kind not being stated, left a deposit of oil and tar in the tubes. And finally that three cords of good dry birch is equal to about one ton of coal for evaporative purposes. If we should pull some old gray beard of the wood burning days of this country out of his retirement, he could tell some interesting tales of the stream of wood that was sent into the Liliputian fireboxes of the engines pulling fast passenger trains. Let's see, a big modern tender will hold about 15 tons or more of coal, calling for an equivalent of about 45 cords of wood. Hardly feasible to accommodate the load and haul the train today. But a heavy load for a wood burner was 10 cars weighing 200 tons.

Catching Visions.

An Australian contemporary makes the following wise reflections which it would be well to ponder and digest: The intellect is no better than a pick or shovel if it is nothing more than an instrument to procure food to eat, a house in which to live, or bonds to place in the deposit vault. He therefore, who would fill a large place, rejoice daily in living, catch beautiful visions, hear harmonious sounds, come into touch with large thoughts, and find himself continually amid a new and more perfect environment must secure the best possible education. Never before in the history of the world was it so important that this thought should be impressed upon our youth. If life today is more strenuous than it ever was before, it is also fullest of possibilities of the higher sort.

The Outlook for Car Equipment

Estimates of the Growing Requirements

Since the recent return from Europe of William H. Woodin, president of the American Car and Foundry Company, he has been discussing the outlook for transportation equipment in the near future, and is assured that every railroad in the world is greatly in need of locomotives, cars and rails, and as they must be kept in condition to carry on the commercial requirements of these countries, vast purchases must be made along these lines. The American plants are in excellent condition, and are in a position to do a great deal of work. Referring particularly to the American Car and Foundry Company, it appears that the company has purchased a substantial stock interest in the Canadian Car and Foundry Company, and will use this plant as a partner in its foreign business. The Canadian company will, however, take no part in American business, the high duty precluding this.

It is estimated that the railroads of the United States will need approximately 849,000 cars during the next three years. The railroads will necessarily begin to renew their equipment, once the roads have been returned to private ownership, and the money will be forthcoming to finance the undertaking. To make up the present apparent shortage, about 240,000 cars are needed. Replacement for retirement through the next three years will require 234,300, and to take care of increased business it is estimated that 375,000 cars will be needed in the three-year period. The replacement figure is usually determined on the basis of an average retirement of 3½ per cent a year, and the increased business figure on the basis of a gain of 5 per cent a year. These requirements, it is asserted, are not beyond the capacity of the car builders of this country, with their ready adaptability to meet increased demands, but it is believed that under the present adverse conditions regarding purchase of steel and other materials, it would not be possible to turn out more than 200,000 cars a year, but it is to be hoped that more stable conditions will gradually prevail in the material as well as in the labor market. Mr. Woodin submits the following table, showing the requirements for replacement of cars and increased business during the succeeding three years:

	Replacement.	To Handle Increased Business.
1920	73,500	118,500
1921	78,000	125,000
1922	82,800	131,700

It may be pointed out that constantly increasing demand is due largely to the fact that as a result of the cessation of industrial activity following the signing of the armistice business was in abeyance in the spring of 1919, as was indicated by the fact that there were large surpluses of cars in all parts of the United States lying idle during those months. Business was again interfered with by the abnormal difficulties due to the coal strike in November and December, but since then the accumulated business has been demanding transportation. The equipment available, despite the great use to which it has been put, is in fairly serviceable condition and has been somewhat improved since the shopmen's strike in August, 1919, which materially interfered with repairs.

During the two years of Federal control the average number of freight cars acquired per year was approximately 84,500, and after allowing for retirements the net average addition was a little in excess of the average net additions during the preceding three years. One hundred thousand cars were ordered in 1918, and represented the maximum for which material and labor could be obtained, in view of the demand for other war necessities. It was impracticable in the order to provide for any additional refrigerator, stock or flat cars, and there is now a shortage in these classes of equipment. No freight cars could be ordered by the administration in 1919. This was due to the clearly understood policy of Congress in favor of the early return of the railroads to private ownership and because of the resulting lack of appropriations to be used for new capital expenditures.

It is gratifying, however, to know that the railroads were enabled in the fall of 1919 to handle an exceptionally large business under exceptionally difficult conditions. The postponement of buying in the spring concentrated an extraordinary demand for commodities in the fall. The problem has been intensified by the falling off in loading per car from 1918, when under pressure of the war very heavy loading was secured. The loading per loaded freight car fell from an average of 29.2 tons in the first eleven months of 1918 to 27.8 tons for the same period of 1919, or a decrease of nearly 5 per cent. This falling off has occurred in spite of the continued efforts of the Railroad Administration, assisted by the co-operation of many shippers.

This is to be regretted, as the increasing demand for transportation of commodities and the necessity for employing our transportation facilities to their maximum, and in the general public interest require that all cars should be loaded and unloaded with expedition, and that likewise all cars should be loaded as nearly to their carrying capacity as possible.

Among the reports of the regional directors, that of Hale Holden, of the Central Western region, is particularly illuminating, as showing the marked increase of traffic in the last half of 1919 as compared with the same period in 1918. In this period there were 1,838,283 loaded freight cars received from the various railway connections into the region, as compared with 1,642,320 loaded cars received in the same period during 1918, showing an increase of over 4 per cent. This showed a marked increase in spite of the fact that, owing to the causes already stated, the traffic in coal was much lighter in the period referred to in 1919 than in 1918.

The saving in the matter of expenses in the region was also reduced during both of the years amounting to a total of $347,062.71, or about 25 per cent as compared with the expenses incurred during 1917, and a further reduction is assured if the same system of regional management continues during 1920.

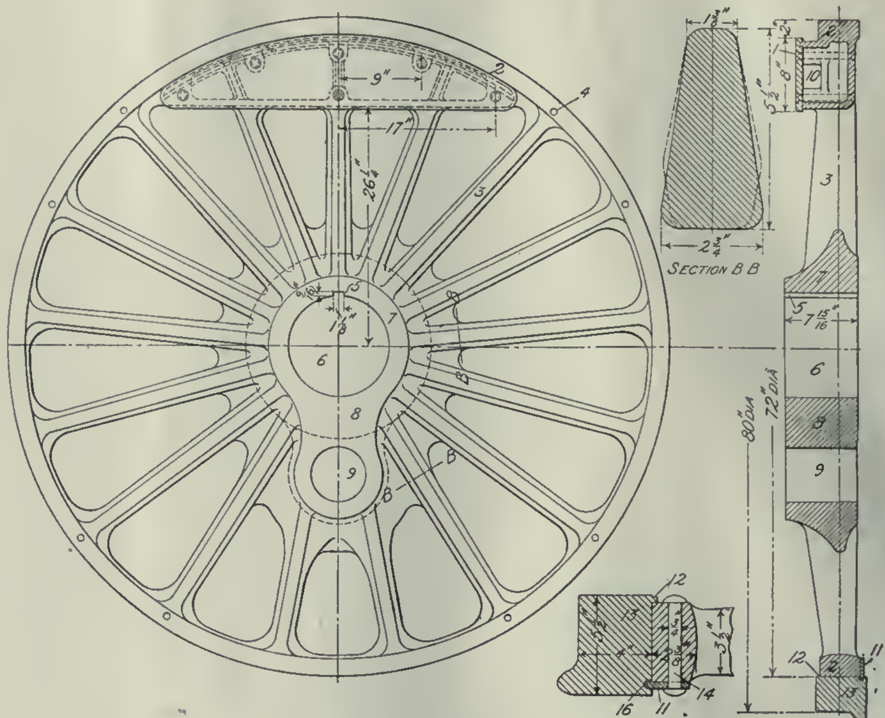
The passenger traffic has also shown a marked increase. This, of course, may be justly attributed to the restriction measures enforced during the war period. The high water mark was reached during the fall of 1919, the month of September showing an increase of over 26 per cent as compared with the passenger traffic in the same region during the same month in 1918. A saving of fuel and also a saving in the lessening of overtime expenses is also recorded, so that it must be admitted that the work of the regional directors has shown considerable improvement during the comparatively short period that the system has been in operation, and in marked contrast to the work of railroad commissions generally, and Federal commissions particularly.

To these gratifying results there should be also added the increased efficiency in the element of safety, the number of fatalities and injuries caused by accidents on railways being reduced in the region referred to by over 200 in the former and over 2,000 in the latter. This admirable feature of the enforcement of precautionary measures looking toward a greater degree of safety, has however been growing for several years previous to the reports to which we have referred, and will continue to grow under any coming condition, as shown by the recent reports of the Bureau of Statistics of the Interstate Commerce Commission.

Details of Parts of the Pacific Type Locomotive as Shown in Our New Chart, No. 12

The illustrations presented herewith show the details of the construction of the driving and trailer truck wheels used in the Pacific locomotive chart. The leading truck wheels were shown in connection with the details of that truck illustrated in the January issue. Those wheels were of the solid rolled steel type, in which the hub web and rim are rolled from a single slab or ingot and are, therefore, integral with each other. In this respect they are different from the wheels that are shown herewith. These wheels are of the built-up variety, that is, they are built up of a cast center upon which a steel tire is fastened.

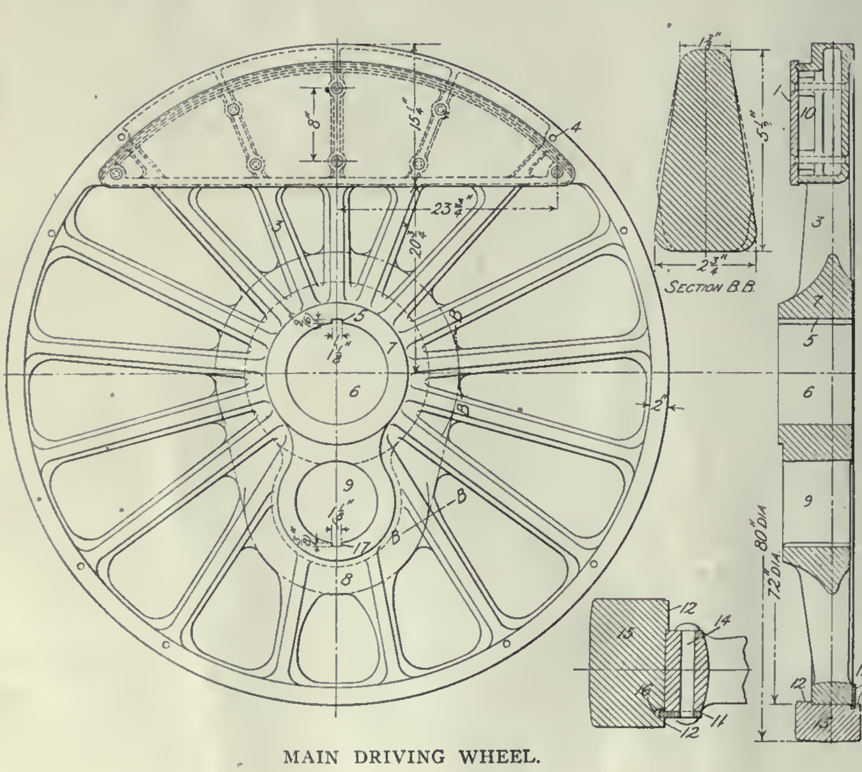
The driving wheels are built-up of a cast steel center having an outside diameter of 72 in. upon which a tire 4 in. thick is placed making a total driving wheel diameter of 80 in. These castings are annealed before turning to dimensions. Both the trailing and main driving wheels are shown in the engraving though the general construction of the two is essentially the same, the difference between the two being mainly that of dimensions. Both wheels are bored for an axle seat 11 in. in diameter and 7 15/16 in. long. and are fitted with a a 9/16 in. by 1⅛ in. keyway for a 1⅛ in. square key by which they are fastened to the axle. With the exception of distance to the crank pin from the center and the outside diameter of the whole, this axle fit is one of the few checking dimensions of the two wheels. From the center to the center of the crank pin seat is 14 in. There is however, considerable difference between the crank pin seats of the two wheels.



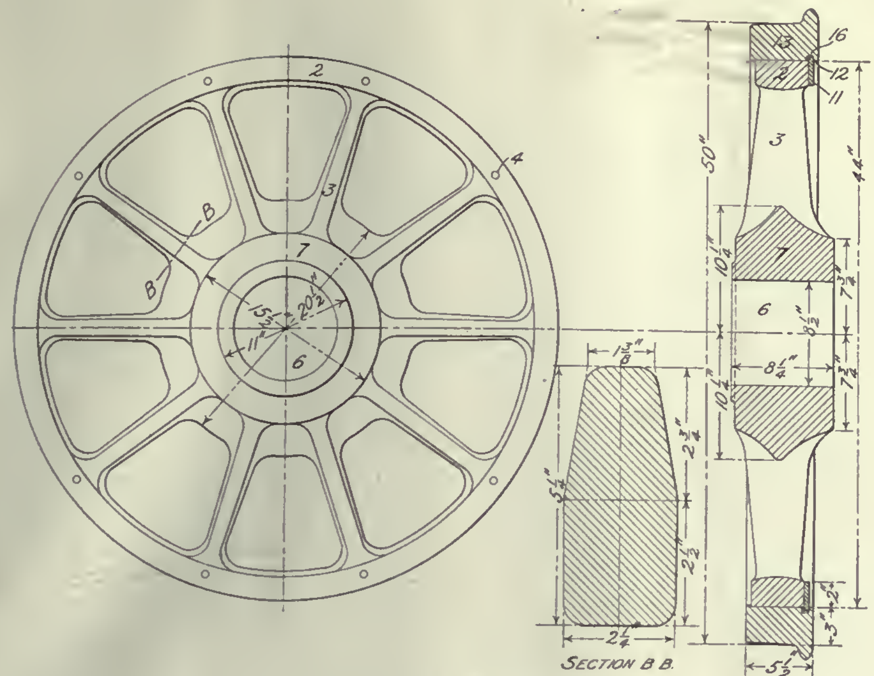
TRAILING DRIVING WHEEL.

The length (7¾ in.) is, of course, the same but the diameter of the seat in the trailing wheels is only 6 in. as against 9 in. for that of the main wheel. But there is little difference in the thickness of the two hubs outside the pin, being 1½ in. for the trailing wheel and 1⅞ in. for the main. It will be noticed, however, that while the trailing crank pin is simply pressed in and is held by the frictional resistance the main pin is held by a key 1⅛ in. square or of the same size as that with which the driver itself is keyed to the axle.

There is, also a marked difference in the size of the counterbalance of the two wheels. That of the trailing wheel has merely to counterbalance the rotating parts while that of the main wheel has to counterbalance a portion of the weight of the reciprocating parts as well. Each consists of a cavity (10) covered by a plate (1) which is riveted in place. The cavity is intended to be filled with the proper weight of lead to meet the requirements of the counterbalance. The tire is fastened to the center by first being shrunk into place. The tightness with which it pinches the center holds, by its frictional resistance against any slipping on the rim. But, in order to prevent any lateral displacement of the tire in case it should become loose, it is held in place by the retaining ring (11).



MAIN DRIVING WHEEL.



TRAILING AXLE WHEEL.

The retaining ring is made in four sections each 15½ in. long measured by the chord of the arc which it subtends and is made up of 2¼ in. by ⅜ in. wrought iron. After the tire has been shrunk into place the four sections of the retaining ring are slipped into the grooves (15) cut in the tire and are riveted in place. It will, thus be seen, that any lateral movement of the tire is prevented even though it may get loose.

In order to permit the necessary freedom of lateral motion of the running gear when rounding curves the tire of the main driving wheel is made without any flange or blind whereby that wheel has a chance to move laterally across the rail.

The trailing truck wheel is of the same construction on a smaller scale. The axle seat is 8½ in. in diameter by 8¼ in. long and the wheel is held in place by pressing only. The outside diameter of the cast steel center is 44 in. upon which a tire 3 in. thick is shrunk, making the total outside diameter of the wheel 50 in. The tire is also held to the center by a retaining ring in the same manner as on the driving wheels.

The reference numbers on the several engravings are indices of the following parts:

1. Counterbalance cover plate.
2. Wheel rim.
3. Spoke.
4. Retaining ring rivet hole.
5. Driving wheel keyway.
6. Axle seat.
7. Wheel hub.
8. Crank hub.
9. Crankpin seat.
10. Counterbalance cavity.
11. Returning ring.
12. Retaining ring lip.
13. Flanged tire.
14. Retaining ring rivet.
15. Blind tire for main driver.
16. Retaining ring groove.

Conveyance of Goods by Tramway

During the war, owing to congestion on the railways in Germany, attempts were made to organize the transit of merchandise and other goods, light and heavy, on the various tramway systems. So successful has this been that it is proposed to continue this method of transport in some towns during peace.

Various methods of conveyance were followed: (1) the use of ordinary street cars either alone or with trailers attached; (2) electric street locomotives, the official inspection cars sometimes being converted for the purpose; (3) in certain cases the railway wagons were either run direct on the tram tracks (where the gauge was the same) or were placed on special trolleys of the proper gauge of the track.

The goods carried by this means consisted at first only of building material and gear for the tramway systems themselves, this material being brought from the railway stations and distributed to definite points. The method was then extended to coal haulage and the transport of ashes, etc., from gas and electricity stations. Certain tramway companies undertook the cartage of milk from the railway stations to the depots, and also the carrying of hot meals from the different communal kitchens. The collection and delivery of single packages was, generally, not undertaken.

The writer states that the times of goods transport can be made to fit in with the ordinary passenger traffic. It is always advisable to despatch the goods traffic before the passenger traffic.

The arrangement of couplings for the special trailer cars, etc., is easily arranged, special couplings being provided where the coupling centre of the two cars varies greatly.

The speed of travel of the goods cars running on the tram rails (some vehicles, such as ordinary street cars, etc., do not) is ordinarily the same as for passenger cars. The taking of curves and the provision of proper brakes on the trailed vehicles require careful consideration.

The "train attendants" are usually provided by the tramway companies or administrations; while the transit of mails, etc., is generally superintended by the postal authorities. In this connection it is noted that the largest tramway hauled as many as three postal vans with one tractor car, and during the operation of the scheme conveyed millions of parcels, etc., to and from the railway stations.

Railroad Track Scales.

The Bureau of Standards Circular No. 53, contains authoritative data regarding the specifications and installation of railroad track scales prepared by a joint committee of the American Railroad Association, and members of four other associations. It will be admitted by those having opportunities to judge that there was great room for improvement in the conditions surrounding the determination of railroad weights, and also in the scales used. The specifications drawn up and presented in the circular have been unanimously approved by the joint committee. The work has been coördinated to produce a standard that should be acceptable to all interests throughout the United States for general use. It may be added that the specifications are intended to apply to knife-edge scales of the straight and tension lever types for weighing cars in railroad service, and reinstallations of old scales should be governed as nearly as practicable by the provisions of the specifications relating to installation of new scales. Copies may be had on application to the Government Printing Office, Washington, D. C.

New Coast Railway in Cuba.

During 1919 work proceeded on the construction of the Cuba Northern railroad, generally known as the North Coast railroad. The road was liberally subsidized by the government, and will eventually run from Moron to Caibarien, and there is already a branch connecting Moron with the main line of the Cuba railroad at Ciego de Avila. The road will open up a section of Cuba hitherto practically untouched, and will aid greatly in bringing sugar for export from the territory around Moron and the western part of Camaguey Province.

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Tests of Decapod Locomotive.

It is a very easy thing to make an egg stand on end if you know how, but it sometimes takes a Columbus to show you. So it seems a very simple thing to design a locomotive for pushing serice that will exert its maximum tractive effect continuously and yet secure the economical advantages of an expanding use of the steam, when the idea embodied in the decapod locomotive of the Pennsylvania R. R. is set forth. The strange thing is that it was not done before. When the idea is offered there is frequently the misconception that the half-stroke cut-off is intended to replace the regular valve arrangement as ordinarily applied. This is not the case, the engine is designed for heavy pusher service where the maximum tractive effort has to be exerted continuously. The tests in the laboratory, from the report of which the article in another column has been compiled, as well as the service on the road the design shows a marked economy for the design over other engines in the same service, as there is nothing new in the construction and nothing novel that need be subjected to test as to endurance or cost of maintenance, there seems to be no good reason why the design should not be accepted and applied on its merits as they appear on the face. This will probably be the case as soon as the facts are known. It did not take long to introduce the Mallet into extensive service, and it is probable that before long there will be many replicas of this new arrangement of valve gear for switching and pusher service.

Individual Effort.

There is an old adage that "every little counts" which is being most beautifully, gloriously and systematically ignored by nearly every man, woman and child of the rank and file in this land of liberty or license of ours. We clamor for the enaction of laws and the placing of restrictions, and then promptly proceed to regard them as not at all applicable to ourselves but as intended solely to make the other fellow behave. Then the privileged classes rise above the law and do as they please, as when the subway and elevated guards in New York, being there to enforce the law against spitting, devote their leisure to expectorating indiscriminately. It really doesn't matter very much that you can't wait until you reach the street, but strike a match on the varnish of a car, for the hasty lighting of your cigarette. But when thousands of you do it every day, it adds very appreciably to the cost of maintenance of the varnish on a car, and, another reason for an increase of rates. It is too much trouble to carry your morning paper to your office and throw it in the waste basket so you drop it on the street or subway track, and as your neighbor does the same, the combination of your laziness and his and others adds many thousand dollars a year to the street cleaning or subway maintenance budgets which comes out of your own pocket in taxes, rent and car fares, all of which might better have been used for other purposes than cleaning up your muss that you need not have made.

We are all too prone to think our own little delinquencies of such minor importance that they don't count, but when we remember we are not alone in their perpetration things assume a different aspect. So in the matter of production. Under the benevolent administration of the Government the man-hour efficiency in certain industries has fallen off as much as 40 per cent. Now the fact that you are doing only two-thirds as much work as you are capable of doing may not bulk very large in the industries of the world, but if, in any community employing a thousand men, this is the prevailing condition, then there would be four hundred men set free for other productive industries if six hundred of the thousand would do what they could.

The whole world is clamoring for more food, more goods, more transportation, more and more of the necessities of life and yet even those men who are loudest in their clamor, the workers, are the very ones who are doing their best to restrict output, for their own selfish advantage, and who seem utterly oblivious to the fact that they are doing their best to wreck the country and that, if they do, they will themselves go down in the general ruin.

There was a time in this country, not much beyond the limits of the memory of living men, when there were many family groups that produced all of their own necessities of life. These were farming groups and the same thing may happen again. If the curtailment of industrial production goes on much longer it is possible that the harassed and weary farmer may also follow suit and produce only for his own consumption, which will mean famine for the worker who sees nothing out of the way in the 40 per cent fall in his own efficiency.

The world is in too parlous condition for these things to be ignored, and if there is any honor, any love of country, or family or even foresight for his personal comfort and safety, it behooves the worker of today to do his best to lift the world out of the state into which it has come. Patriotism evidently cannot do it, because there are no signs that it was universally dominant even in the days of our greatest stress; so it must be self-interest and self-preservation that will save the day. And the day can hardly be saved until we all come to a realization that, while individual effort in itself may be insignificant when compared with the great whole, it is still the aggregate of these efforts that will save the day just as it won the war. So as we girded up our loins for the supreme effort and won, let us as individuals and organizations of labor and capital, of parlor agitators and those who think, remember that we are all indissolubly connected and that the ruin of one may mean the ruin of all, and that the one sure way of salvation for us and the world lies in work. Work, efficient work of the individual, of the collective organization, of all, and that none can shirk the responsibility thereof.

The Work of the Division of Labor.

Among the contradictory reports and acrimonious debates that come to us in a never-ceasing supply, it is pleasant to note here and there glimmerings of common sense, like starlights in a storm, showing not only that the stars are still there, but that the storm may eventually subside. Among other official documents the report of W. S. Carter, Director Division of Labor, is particularly commendable, not only for its lucidity, which we expected, but for its fairness to all concerned. Mr. Carter requires no recommendation at our hands, but it not infrequently happens that the atmosphere of officialdom at Washington spoils a good man. We are well aware that Mr. Carter, like Daniel, has been in a den of lions, but he comes out unscathed. In his annual report, among other details, he recommends the continuance, even after the end of Government operation of railroads, of the Boards of Adjustment set up by the Railroad Administration to render decisions on controversies arising out of the application of wage orders, and on other disputes between railroad officials and employees. Mr. Carter states in his report that the work of these boards demonstrates not only the advisability of the creation of such boards, but the necessity of their continuance either under Federal control of railroads or thereafter. The fact that the boards are bipartisan, with umpire or neutral member, and all of which members are experts on railroad agreement matters, has led both officials and employees to have confidence not only in the fairness of decisions reached, but as to the technical ability of the members of the boards to pass intelligently upon all controversies submitted for decision.

During the two or three years antedating Federal control of the railroads an alarming situation was created in that the employees' organizations, as a whole and through federations, found themselves confronted with similar federations on the part of the railroads, the roads being represented by conference committees and the conference committees being subordinate to advisory committees. It was alleged by employees that these conference committees of all of the principal railroads in a district were not permitted to grant the demands of employees, or even to make favorable compromises, without the consent of the advisory committee. The advisory committee it was alleged was the agent of the great banking institutions that controlled the financial policy of all of the railroads.

There seems to have been a public opinion that any man, even indirectly connected with labor, would be unqualified to act as a neutral arbitrator, with the result that most estimable gentlemen who had never had any connection with, and who had little knowledge of, labor conditions were called upon to act as umpires in these great contests. It was alleged by the employes that usually these arbitrators, having no technical knowledge of wage schedules, often made awards that were difficult of interpretation, if they did not, in fact, bring about conditions the very opposite to that intended by the neutral arbitrator. It also became apparent that in the application of the arbitration award the officials of a railroad were the sole administrators thereof, with the result that after employees had been led to believe that an arbitration award brought them much relief it was applied in a manner that took away from them more than had been given them.

It may be truthfully said that at the time the railroads passed under Federal control, because of these vexatious contentions, the morale of railway employes had sunk to a low degree. In many instances there was an entire absence of esprit de corps, so necessary for efficient operation.

During the year 1919 a considerable number of minor strikes occurred, practically all of which were not authorized by the organization of which the employes were members. A major proportion of these strikes were adjusted through the initiative of the Division of Labor. In some instances the representatives of this division used their good offices to bring about a final adjustment, but in other instances activities of the representatives of the division ceased when the strikers returned to work and the original controversy was referred by mutual consent back to the officials and employes of the railroads to adjust.

It is believed that a vast majority of these unauthorized strikes arose out of the fact that the employes at these local points did not fully understand that a proper tribunal had been created by the Railroad Administration to which all controversies should be referred and that equitable decisions would be reached by such tribunal.

Comments on the British Railways.

A British contemporary commenting on the hours in railroad service claims that the limitation of working hours is a commendable principle, and he will argue that the eight-hour day was in any degree unjustifiable; but in railway service the changes entailed thereby have been far-reaching, and the cost of railway working greatly increased. On certain duties, especially signalling and in cases where a 24-hour day was conveniently divided into three 8-hour shifts, the principle was already in vogue, but many traffic duties were well served by two 10-hour shifts, so that the 8-hour system was not easy of adaptation. Moreover, a decrease from 10 hours to 8 hours requires a staff increase of 25 per cent. to realize the same total of working hours, though frequently there is not accommodation for the additional men required to do the same amount of work in 8 or 16 hours, while to complete 10 or 20 hours by means of overlapping or broken shifts is often neither desirable. nor practicable without causing other difficulties.

The railway machine working less time can no more put through the same amount of work as formerly than any other kind of industrial machine could. The real remedy would seem to be in increasing the size of the machine to correspond with the diminished working hours, and that could only be done by a vast expenditure of capital on new lines, rolling stock, and other plant. In the present state of the money market in general, and the railway share market in particular, there seems to be no immediate chance of this capital forthcoming. Even were the most favorable terms given to railway proprietors to induce them to find more capital it would take many years to put right the position which has grown so apparently hopeless. But the problem must be tackled if the future prosperity of the country is not to be jeopardized, and no good purpose will be served by those in authority delaying a moment longer to take it in hand.

The foregoing remarks naturally lead up to the question of nationalization, and it is interesting to note in that connection that the United States Senate has passed a bill with the object of immediately restoring the railways of that country to private ownership, their experience of State control having been even more unsatisfactory than in Britain. In pre-war days the German State railways were held up as an example of the efficiency of State management by those in this country who favored nationalization. In the light of recent experience, it looks as if the German State railways had owed their efficiency to Prussian methods of management, which are foreign to the genius of our race. It is worth noting that since these railways came under democratic control their efficiency has continued to decline, so much so that they have actually had to suspend entirely passenger traffic for weeks at a time. Except among a certain section of organized workers, there seems to be little demand for the nationalization of our industries, and it is possible that the nation as a whole would be quite satisfied, after the taste which it has had of State control and interference with their activities, to see our mines, railways, and all other industries once more under the progressive influence of private enterprise.

Increase of Railroad Rates in Britain.

The Ministry of Transport has announced a general increase of all freight rates in the British railways. The advance ranges from 12 to 48 cents a ton in the price of coal, according to the transport distance. Iron and structural steel, and many manufactured articles will have an additional charge of 50 per cent over the flat rate. The classification is very complex, but evidently prepared with precision as necessarily bulk as well as weight receiving due consideration.

Safety First.

Amid the storm and clash of varying opinions regarding railroad problems it is a matter of congratulation that in spite of increasing traffic the safety first movement is making real progress.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page* 19, *Jan.*, 1920.)

1064. Q.—Are these restrictions readily removed?

A.—Usually they are, but sometimes it is necessary to remove the supply valve bushing.

1065. Q.—How is a restriction in the port to the supply valve detected?

A.—By operating the valve by unseating the regulating valve with the finger or a hammer handle.

1066. Q.—And this results in what?

A.—A discharge of air from the exposed port "c" each time the supply valve and piston are moved.

1067. Q.—How is an obstruction from the port leading from the piston bushing to the regulating valve detected?

A.—By removing the supply valve and piston, replacing the cap nut, removing the regulating valve and cap nut, holding the finger over the port "c" and turning on the air pressure slightly.

1068. Q.—Why cannot this be accurately determined without removing the supply valve piston?

A.—Because all the air issuing from the regulating valve cavity must first pass the supply valve piston.

1069. Q.—And what is volume restricted to?

A.—A trifle less than that which can flow through a 3/64 in. circular orifice.

1070. Q.—What is the cause of the feed valve sometimes making a high pitched or squeaky noise?

A.—This is caused by a vibration of the diaphragm spindle, either due to the spindle being too loose in the adjusting nut, or through the end coils of the regulating spring being solid on the adjacent coil.

1071. Q.—How is the latter defect sometimes overcome and the noise stopped?

A.—By using a hammer and chisel to separate the end coils after which the ends of the spring are ground off squarely.

1072. Q.—Why must a great deal of importance be attached to the repair work on feed valves?

A.—Because the successful operation of brakes on modern lengths of trains depends largely upon a predetermined pressure being maintained in the brake pipe.

1073. Q.—Is it possible for undesired quick action to originate through a defective feed valve and brake pipe leakage?

A.—Yes, if the triple valves are not in first-class condition.

1074. Q.—How much if a 20-lb. brake pipe reduction is then made, single top governor?

A.—50 lbs. excess pressure to release the brakes with.

1075. Q.—What is the difference between a B-6 feed valve and a C-6 reducing valve?

A.—The feed valve has a hand wheel adjustment.

1076. Q.—What is the difference between the B-4 and the B-3 valves?

A.—The same difference in regulating the pressure, the B-4 has the hand wheel arrangement.

1077. Q.—What is the difference between the B-4-A and the B-4, or the B-3-A and the B-3 valves?

A.—The A valves are of a converted type, having a larger regulating valve.

1078. Q.—What type of regulating valve?

A.—The same type that is used in the B-6 and C-6 valves.

1079. Q.—How are these two types of valves distinguished from outward appearances?

A.—The number 6 valves are straight at the outside of the piston bushing, while what is termed the number 4 valve has a flange at the point where the cap nut screws into the body.

1080. Q.—What is the object of the graduating valve?

A.—To make the valve more sensitive to movement in supplying small brake pipe leaks.

1081. Q.—In what way?

A.—It is intended that at such times only the piston and graduating valve shall move, up to the time that leakage is sufficient or the supply necessitates the movement of the supply valve.

1082. Q.—What is the maximum combined amount of metal that may be removed from the rotary valve and seat during repairs?

A.—⅛ in.

1083. Q.—Or from either the valve or seat alone?

A.—1/16 in.

1084. Q.—When in position, rotary valve on its seat, what is the distance from the base of the rotary valve, or rather the circular seat, to the top of the rotary valve seat of the H-6 brake valve when new?

A.—1½ ins.

1085. Q.—What is the condemning limit for one of the parts?

A.—1⅜ ins.

1086. Q.—Can a rotary valve ever be used if it has been reduced more than 1/16 in thickness.

A.—Yes, if it is used on a new valve seat.

1087. Q.—Can a seat that is worn, say 1/32 in. below the condemning limit be used?

A.—It can in case a new valve is used, so that the combined distance is 1⅞ ins. or more; however, it is best to scrap the valves or seats after a full 1/16 in. has been removed.

1088. Q.—What is the full engagement of the key in the valve?

A.—⅜ in.

1089. Q.—How much when in service after ⅛ has been removed through facing off and the rotary key gasket is worn out?

A.—Less than ⅛ in.

1090. Q.—How is the metal removed from the rotary valve and seat?

A.—A small amount through wear, the majority in facing the valve and seat for obtaining an airtight bearing of the rotary valve on its seat.

1091. Q.—What results for an imperfect bearing of the valve on the seat?

A.—What is termed a leaky rotary valve.

1092. Q.—What is the effect?

A.—It leaks main reservoir pressure into the brake pipe.

1093. Q.—With what result?

A.—An increase in brake pipe pressure, if the leakage from the brake pipe is not in excess of the leakage into it.

1094. Q.—What effect will an increase in brake pipe pressure have on the equalizing portion of the distributing valve when the brake is applied?

A.—If the pressure leaks in faster then the brake pipe pressure leaks past the packing ring of the equalizing valve into the pressure chamber and can increase brake pipe pressure sufficiently above pressure chamber pressure to force the equalizing valve to move, the equalizing portion will move to release position.

1095. Q.—Will the increase in brake pipe pressure and the movement of the equalizing portion of the distributing valve result in a release of the brakes on the locomotive?

A.—No.

1096. Q.—Why not?

A.—With the standard equipment the automatic brake valve being on lap position, the release pipe is closed and the application cylinder pressure cannot escape.

1097. Q.—Why does the brake fail to release if the leakage past the equalizing piston packing ring of the distributing valve is equal to the leakage into the brake pipe from other source?

A.—Because the pressure chamber keeps equal to that increase in the brake pipe, and differential required for movement cannot be obtained.

(To be continued.)

Train Handling.

(Continued from page 20, Jan., 1920.)

1109. Q.—How is supplementary reservoir pressure admitted to the auxiliary reservoir?

A.—Through the by-pass valve.

1110. Q.—How is the by-pass valve operated?

A.—The movement of the triple valve slide valve to emergency position opens one side of the by-pass piston to the brake cylinder exhausting auxiliary reservoir pressure from that side, while the pressure on the other side opens the valve.

1111. Q.—What figure does the safety valve limit the brake cylinder pressure to in service operation?

A.—To 60 lbs.

1112. Q.—What brake cylinder pressure will then be obtained for a 24-lb. brake pipe reduction?

A.—60 lbs.

1113. Q.—From a brake pipe pressure of 90 lbs. same 24 lbs. reduction?

A.—60 lbs.

1114. Q.—Why is this?

A.—The same number of cubic inches of free air leave the auxiliary reservoir in either case.

1115. Q.—What is meant by the expression, PC equipment?

A.—The passenger control equipment.

1116. Q.—Outside of the usual brake pipe, conductors valve, dirt collector and automatic brake slack adjuster, what does this equipment consist of?

A.—A control valve and reservoir, a service and emergency reservoir and two brake cylinders.

1117. Q.—What are the names of the cylinders?

A.—Service and emergency.

1118. Q.—What is the emergency brake cylinder used for?

A.—During quick action or emergency operation.

1119. Q.—And the service cylinder?

A.—For both service and emergency applications.

1120. Q.—What is the service reservoir used for?

A.—To store a supply of compressed air for the operation of the service brake cylinder.

1121. Q.—And the emergency reservoir?

A.—For the operation of the emergency brake cylinder, for a recharge of the service reservoir and to provide a graduated release of brakes when desired.

1122. Q.—What is the control valve reservoir used for?

A.—As a base for mounting the different portions of the control valve, and to serve a supply of compressed air to assist in the operation of the control valve as well as for other purposes that will be mentioned later.

1123. Q.—What are the names of the different portions of the control valve?

A.—Equalizing portion, application portion, quick action portion and emergency portion.

1124. Q.—What is the equalizing portion used for?

A.—Principally to control the application and release of the brake and for charging the pressure chamber of the control valve reservoir.

1125. Q.—How is it operated?

A.—By obtaining a differential in pressure between the brake pipe and the pressure chamber.

1126. Q.—What are the names of the compartments of the control valve reservoir?

A.—The pressure chamber, the application chamber and the reduction limiting chamber.

1127. Q.—What is the applicaiton portion used for?

A.—Principally to control the flow of air from the service reservoir to the service brake cylinder, to maintain the service brake cylinder pressure at a fixed pressure, and to control the flow of air from the service brake cylinder to the atmosphere.

1128. Q.—What is the emergency portion used for?

A.—Principally to control the flow of air from the emergency reservoir to the emergency brake cylinder and from the emergency brake cylinder to the atmosphere.

1129. Q.—What is the quick action portion used for?

A.—To discharge brake pipe pressure to the atmosphere for the continuation of quick action after it has originated.

1130. Q.—What is the principal use of the pressure chamber air?

A.—To operate the equalizing, release and application pistons.

1131. Q.—What is the application chamber used for?

A.—As an enlargement of the application cylinder.

1132. Q.—What is the difference between the operation of the application portions of the distributing valve and the control valve?

A.—In the control valve the application is retarded by an application piston spring, and the supply of the control valve is limited to the capacity of the service reservoir.

1133. Q.—What is the reduction limiting chamber used for?

A.—As an overflow reservoir for the pressure chamber, after the pressure and application chambers have equalized during a heavy service brake pipe reduction.

1134. Q.—What portion of the control valve happens to be located in the reduction limiting chamber?

A.—The application portion.

1135. Q.—What are the principal parts of the application portion?

A.—An equalizing piston, slide valve and graduating valve, a release piston, slide valve and graduating valve, a graduated release cap, a service reservoir charging valve and three check valves.

1136. Q.—What are the names of these check valves?

A.—Equalizing, pressure chamber, and emergency reservoir check valve.

1137. Q.—What are the principal parts of the application portion?

A.—An application piston to which is attached an application and an exhaust valve.

1138. Q.—Of the emergency portion?

A.—A double ended emergency piston and slide valve.

1139. Q.—Of the quick action portion?

A.—A quick action piston, a quick action valve and a quick action closing valve.

1140 Q.—What is the object of the pressure chamber check valve?

A.—To permit a free flow of air from the pressure chamber to the equalizing portion during an application of the brake, but to prevent any flow from the equalizing portion to the pressure chamber except through the regular charging ports.

1141. Q.—What is the emergency reservoir check valve used for?

A.—To prevent a back flow of air from the emergency reservoir while the brake is applying or applied.

1142. Q.—What is the object of the equalizing check valve?

A.—To prevent a back flow of air into the brake pipe when the brake is being applied.

(To be continued.)

Car Brake Inspection.

(Continued from page 20, Jan., 1920.)

1026. Q.—How is the release test made?

A.—In the same manner as with a triple valve, pressure chamber pressure above the diaphragm of the differential valve and brake pipe pressure below, and if the vent port opens before the valve moves to release position, it indicates undue friction.

1027. Q.—With the brake applied, leakage into the brake pipe is from where?

A.—Past the equalizing or release piston cylinder cover gaskets.

1028. Q.—During a continuous reduction in brake pipe pressure at what time should the brake go into quick action or emergency?

A.—When brake pipe pressure is between 55 and 65 lbs. from a 110-lb. pressure.

1029. Q.—How is the sensitiveness of the application portion noted?

A.—By making a 10-lb. brake pipe reduction, and a leak in the brake cylinder volume, the fluctuation of the brake cylinder gage hand will show this.

1030. Q.—What will the fluctuation be, if the application portion is in good condition?

A.—Not over 8 lbs.

1031. Q.—What is the maximum amount permissible?

A.—It should not be over 10 lbs.

1032. Q.—Why cannot this be kept below 5 lbs.?

A.—On account of the tension of the application piston graduating spring.

1033. Q.—After a full service application of 24 lbs. reduction in brake pipe pressure how long should it take to reduce the application chamber pressure to 5 lbs.?

A.—From 4 to 6 seconds from the time the brake valve is moved to release position.

1034. Q.—With the graduated release cap in graduated release position, how many graduations should be obtained after a 20-lb. brake pipe reduction?

A.—At least 3 before the brake cylinder pressure is entirely exhausted.

1035. Q.—After a brake application and release, at what time should the charging valve open and charge the service reservoir?

A.—When the pressure chamber pressure is within 5 lbs. of the pressure in the emergency reservoir.

1036. Q.—With the graduated release cap in what position?

A.—In direct release position.

1037. Q.—And a failure of the charging valve to open indicates?

A.—Excessive friction or excessive packing ring leakage about the charging valve.

1038. Q.—How should these valves be lubricated?

A.—With a good grade of fine, dry graphite throughout, or on all parts specified for lubrication.

1039. Q.—Why should not a good grade of oil be used on the equalizing and release piston packing rings?

A.—Oil or grease is merely a dirt collector and collects dust and dirt on the parts it is applied to.

1040. Q.—Will there not be an extraordinary amount of wear on the parts if oil is not used?

A.—Examinations of slide valves indicate that there is less actual wear when the valves and seats are dry than when lubricated with oil or grease.

1041 Q.—Why is this?

A.—When the slide valves are dry there is a certain amount of leakage or air percolates between the valve and seat, tending to balance the air pressure offering less resistance to movement than when oil or grease is used.

1042. Q.—And under this condition?

A.—The edges of the slide valve being "packed" to the exclusion of leakage, the full pressure chamber pressure per square inch is effective on the slide valve rendering it more difficult to move.

1043. Q.—Resulting in what?

A.—Generally in undesired quick action and stuck brakes.

1044. Q.—Is this a logical conclusion?

A.—Yes, an examination of a triple valve that has been in service for some time, when the slide valve has been lubricated with oil or grease, shows a heavy shoulder on the seat between service and emergency positions, and this is not found if the valve remains dry, or lubricated with dry graphite.

1045. Q.—What is the universal valve?

A.—The car brake operating valve of the "UC" brake or the electro-pneumatic brake for steam road service.

1046. Q.—What is required to change a car from PM to UC equipment?

A.—The universal valve and bracket, and an auxiliary, service and emergency reservoir.

1047. Q.—Will not the auxiliary of the PM equipment serve the purpose?

A.—No, the auxiliary and service reservoirs are of a different size.

1048. Q.—The capacity of the auxiliary reservoir of the PM brake is equal to what?

A.—The combined capacity of the auxiliary and service reservoir of the UC equipment.

1049. Q.—The universal valve consists of what?

A.—An equalizing portion, a quick action portion and a high pressure cap mounted on a bracket containing two air storage chambers.

1050. Q.—Is there any other portion for electric service?

A.—Yes, the magnet bracket portion.

1051. Q.—How many different brake cylinder installations may be operated with the universal valve?

A.—Three, one brake cylinder for both service and emergency, two brake cylinders per car both for service and emergency operation, and two cylinder per car, one for service and both for emergency.

1052. Q.—How many different sizes of universal valve are required for this?

A.—But one size for any arrangement desired.

1053. Q.—What controls the flow of air to and from the brake cylinders in volume, to produce uniform operation with the various sizes and number of cylinders when there is but one size of operating valve?

A.—Service and exhaust port chokes in the pipe bracket.

1054. Q.—Is there any change in the parts of the universal valve when two cylinders are used both for service and both for emergency?

A.—No, it is the same as for the single cylinder equipment.

1055. Q.—When one cylinder is used for service and two for emergency?

A.—In this event a different high pressure cap is used.

1056. Q.—The equalizing portion does the work of what?

A.—An improved plain triple valve.

1057. Q.—And the quick action portion and high pressure cap are used for?

A.—Emergency operation.

1058. Q.—Sometimes there is an additional small emergency reservoir used in addition to the large emergency reservoir?

A.—This means that the large reservoir is used for quick recharge, and graduated release if desired and the small emergency reservoir only for additional emergency brake cylinder pressure.

1059. Q.—And in this case, emergency brake cylinder pressure or emergency braking ratio is governed by what?

A.—The size of the small emergency reservoir.

1060. Q.—And service braking ratio?

A.—By the adjustment of the safety valve.

1061. Q.—And when 150 per cent emergency braking ratio or even more is required?

A.—The small emergency reservoir is eliminated and the large reservoir supplies the brake cylinder or equalizes with it in emergency operation.

(*To be continued.*)

Useless Scientific Publication.

The *Scientific American* says that it would be amusing, if it were not so deadly pathetic, to see the grotesque profundity of the "Proceedings" and "Journals" and "Transactions" of the little frontier museums and scientific societies that seem to think they must produce each year a lot of mystifying printed matter or perish. And furthermore, no man of science who values his reputation in scientific circles at the price of a good lead pencil dares to say—openly—one word against those existing traditions and practices. It is a great pity that some leading man of science does not resolutely and courageously call a halt on the waste of time, men, money and print paper that now is put into the dregs and rubbish of science.

The Metric System.

The world trade club of San Francisco, consisting of one rich old man, and a few deadheads are engaged in a metric propaganda. It is unworthy of any serious attention, and is doomed to the same fate an Andrew Carnegie's attempt to revive spelling. Mr. Carnegie was a rich man but a very poor author. The Wealthy Californian should have trustees appointed to protect him from rapine and ridicule.

Electric Welding of Cast Iron

By J. F. Springer

The simple welding of cast iron, whether by the electric or the gas process, is a procedure rather free from difficulty. That is, it is comparatively easy to fill up the crevice and secure a union. But other matters have to be taken into account. Thus, it is often of importance that the welded region be machined subsequently to the welding operations. Spots of hard white iron will then not be wanted. But white iron is liable to form in the course of the welding operation. In fact, if proper precautions are not taken, the region may turn out to be, from a practical, commercial point of view, impossible to machine. Again, cast iron is subject to cracking when heated locally. One may succeed with the weld itself, only to find a new crack elsewhere.

White iron may be regarded as a kind of steel which has a very large percentage of carbon in it. It differs from gray cast iron in this: in gray iron, the carbon exists largely or principally in the form of graphite. It is not in chemical combination with the iron; in white iron, the carbon is largely in combination with the iron. If white iron is suddenly chilled from a considerable heat, it becomes excessively hard, so that it is well-nigh impossible to cut it with the ordinary machine tools. It may, of course, be cut with grinding machines; but these are not always available and may not at times be successful in doing the required machining.

The pre-heating of cast iron is desirbale as affording a means of preventing the sudden chilling of the weld. Suppose, for example, that one is engaged in electrically welding a cast iron cylinder. The whole cylinder may properly be preheated. This may be done in various ways. An oven or furnace may be built up around the cylinder, loose brick being laid in place to form the side walls and a cover of sheet metal supplying the top. An opening is left in one wall for the use of the pre-heating torch. This torch may be a simple affair, deriving its flame from the consumption of oil. There should be a blast of some kind so as to produce a big, active flame. This flame is now introduced into the opening left in the side wall and so directed as to encircle the cylindrical casting. The operator must judge whether a second torch will be needed so as to provide for heating the whole cylinder and thus avoid a sharp change from a highly heated region to one not heated at all. Or, the case may lend itself better to a different manner of handling. Thus, the shape of the casting may be such that a charcoal fire may be operated beneath the region to be repaired. Or, the size and shape may be such that the whole casting may readily be heated all over in some furnace already existent.

It may not be quite evident to the reader how this pre-heating is going to prevent a sudden chill of the weld after the welding operation. The reason for the prevention lies in the great mass of the metal surrounding the weld. It is usually much greater than the amount of material in the weld itself; and this means a slow cooling of the whole. Thus, the excessive hardening is avoided.

Pre-heating is valuable, when properly managed, in connection with the avoidance of cracking. This needs, perhaps, a word of explanation. The heating and cooling of metals produce expansions and contractions of their mass. The blacksmith makes use of these changes in putting a tire on a wooden felloe. The tire is made slightly small and then heated up, say, to a bright red, when it is found to be a trifle large. The metal has expanded. It is then slipped onto the felloe and the whole drenched with water. The cooling causes the metal to shrink and hold the felloe in a tight grip. Now, while the expansion and contraction of a metal is insgnificant for a few degrees, it becomes considerable when a large number of degrees are concerned.

CAST IRON FRONT END OF LOCOMOTIVE SHOWING CRACKS WELDED WITH U. S. L. ARC WELDER WITHOUT REMOVING FROM LOCOMOTIVE.

Consider a moment. There is a crack in the center of a big cast slab or plate. The electric welding process heats up the immediate region of the crack, but has little or no effect on outlying parts. The result is that the center expands, while the surrounding metal remains unchanged. Is it surprising if something gives way and a crack develops? Again, suppose a crack has been filled up by the electric process, the form of the casting being such that no crack resulted in the metal away from the weld. Now, all the metal in the weld has been at or very near the melting point, and perhaps also a thin layer of the casting at the surface of contact. This means that there is a slug of metal of about the size of the weld which will have a big range of temperature through which to cool and that the casting surrounding it will have a very moderate range. This results in a big shrinkage for one and a small one for the other. Is it surprising, then, if, upon cooling, the slug of metal pulls away from one side of the groove? Pre-heating tends to prevent this cracking away of the weld from the casting, because it increases the heated region, and, when managed properly, will provide against sudden and big changes of temperature as one passes from point to point. The heat shades off to low temperatures in a gradual manner.

It may surprise the reader that the procedure of welding up gray cast iron is liable to produce white iron. It is understood that in foundry practice, gray cast iron is kept from turning into white iron by the introduction of silicon into the melt. When the electric process is used to melt gray cast iron into a groove in a gray iron casting, it appears that the excessive heat tends to burn out more or less silicon. Naturally, then, if silicon be needed to prevent the formation of white iron, this loss of silicon might easily result in white iron spots and lumps and the like. This result can probably be checked or altogether prevented by using an electrode, or filling rod, which contains an excessive amount of silicon—enough for itself after undergoing some loss. It seems advisable, then, to use a gray cast iron electrode made by a recipe prescribing a high amount of silicon. Or, if a metal electrode is not employed and the filling material obtained from a separate rod, then this rod may very well be of a high silicon gray cast iron. Vaporization has been suggested by at least one writer upon gas welding.

There is one other matter to which attention should be directed. The slug of metal which makes up the weld is itself a casting. Now, in foundries a good deal of trouble is experienced from blow holes. These are cavities in the mass of the casting. They are big and little, and are probably due to the presence of uncombined gases in the molten metal when the casting was poured. Manganese is a substance having great avidity for oxygen. Its presence in a casting tends to prevent blow holes; and this is doubtless due to the formation of manganese oxide. The oxide floats and goes off in the slag. The foregoing analysis of what occurs in connection with manganese is substantially correct. At any rate, in electric welding, manganese appears to be highly desirable for the purpose of producing a solid slug of metal instead of a porous one.

That cast iron can be successfully welded by the electric process is capable of a notable illustration. However, I do not say that all the electric systems on the market are equally suited to this class of welding, nor that all operators are equally successful even with the same equipment. At the same time, during the war some very fine results were obtained.

When the United States Government took over some 288,780 gross tons of German ships, it was discovered that an appalling amount of damage had been done by the Germans before they were made powerless. All kinds of metal parts were damaged, some were big and some were little. Among the big parts damaged were engine cylinders of cast iron. Some of these were nine feet in diameter. The Germans seem to have been pretty confident that they had put Uncle Sam into a pretty tight box, for a note or memorandum was found on one of the ships to the effect that certain parts could not be repaired. In the language of the people who provided the system which succeeded nevertheless, the American "welder couldn't read German, and didn't know the job couldn't be done, so went ahead and did it."

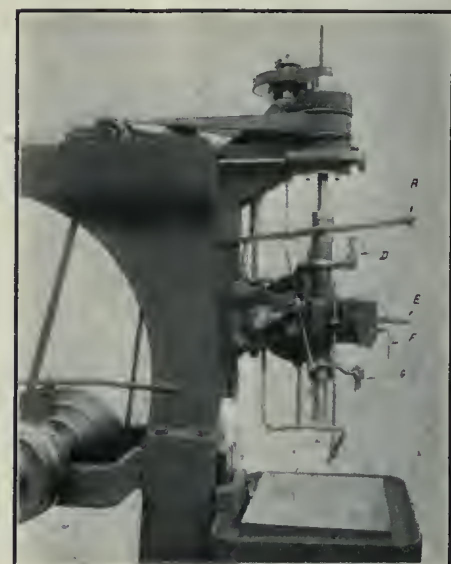
The cylinders were welded in place, without pre-heating. Not all of the work that had to be done by way of repairs was done by electric welding. Some repairs were effected by mechanical arrangements. However, the cylinders of fifteen of the German vessels were electrically welded. The larger breaks were not all of them in cylinders. Eighty-two major breaks were welded, and but 36 mechanically repaired by patches.

Capt. E. P. Jessop, who was a responsible officer having to do with these repairs states: "The writer personally tested many welds for tensile strength, in which cast iron was welded to cast steel, and in but one case was there a failure to obtain practically the original strength, and that case was due to an inexperienced operator burning the metal, and was easily detected as an inferior weld without the strength test being applied."

These facts afford another proof, if proof be necessary, that in the atmosphere of American enterprise, all the boasted scientific attainment of "cultured" Germany may be added to by humbly learning lessons from the American mechanic who in addition to perusing learned disquisitions, has developed the faculty of self-reliance combined with common sense.

Automatic Drilling Machine

The accompanying illustration shows a photographic view of what is known as the "Avey" automatic drilling machine, manufactured by the Cincinnati Machinery Company of Cincinnati, Ohio. The machine combines the features of automatic, semi-automatic, and plain hand feed drill, without the loss of time in changing from one kind of style to another. In running automatically both the approach and the return of the spindle are automatic, the continuous cycle of operations going on without the necessity of engaging or disengaging the feed by the operator. The strokes may be readily varied in length from a maximum of 5 ins. to a minimum of ⅜ in. The greatest number of strokes is 30 per minute. There are four variations in speeds and an equal number of feeds, as may be desired. The medium capacity for drilling is ¾ in. in cast iron,



"AVERY" AUTOMATIC DRILLING MACHINE.

and ⅝ in. in steel. The maximum number of 3,500 revolutions per minute permits of a wide range in the smaller work.

A special advantage is also furnished in advancing the spindle by hand ahead of the regular power feed without disengaging the latter. Movable clutches pick up the power feed instantly and automatically wherever the hand feed drops it. Extra bar A, directly in front of the operator, is used for this purpose, and the clutch is so designed that it is possible to drill blind holes of a uniform depth, with the addition of being always under complete control, and can be disengaged at any point by means of the lever F, or, as previously explained, advanced or jumped at will. A spring plunger receives the shock of the returning spindle, and the overweight can also be regulated exactly to counterbalance different weights of tools.

The clutch lever E is adapted to engage the feed down to depth determined by the graduated depth stop D, tripping automatically, and returning to the starting position, while the change from full to semi-automatic feeding is obtained by giving a quarter turn to the pin G, so that the power feed is engaged or not when the spindle returns, as desired.

The machine is practically noiseless in operation, as the main bearings are all mounted on annular ball bearings, and the machine may be made to use any number of spindles from one to six. In the general output of work the average production if from three to six times that of hand or regular power feed drills, and much less energy is expended under any condition to secure this important amount of increase.

Several valuable attachments can be added to the machine to enable it to meet special requirements in drilling. Among these are two which are especially interesting; one is an automatic cutoff valve for the lubricant whereby the latter flows only while the drill is cutting, thus avoiding the unpleasant splashing of the lubricant on the operator when loading the fixtures for changing the work. The other we refer to, is a stroke-limiting device which automatically controls the number of strokes the spindle will make before stopping. The advantage of this will be seen in connection with automatic fixtures when operating on pieces with more than one hole of the same diameter.

Belgian Railways.

The number of locomotives on the Belgian railways in July, 1914, was 4,372, of which 3,757 were in active operation. On August 1, 1919, there were but 2,479 locomotives in operation, with 680 in repair shops. On this date there were no less than 1,209 locomotives which could not be effectively repaired. Orders for new locomotives have been placed in Great Britain, the United States, and in Belgium, but no immediate relief is to be expected.

Before the war there were 8,192 passenger cars in operation, while in the month of November, 1919, the total, including those reclaimed from Germany, was but 6,755. It should also be remembered that most of the cars reclaimed from Germany are in poor condition and in need of constant repairs. Of the 95,322 freight cars in operation in 1914 there are at present 77,023 in operation. Heavy orders for freight cars have been placed abroad and it is expected that by the end of the present year the equipment both in locomotives and cars will be in condition, both in regard to numbers and fitness for service, to meet the growing demands of the needs of the country.

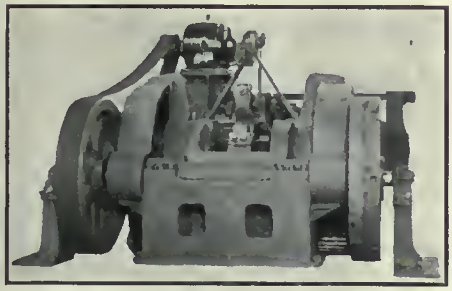
New Model Upsetting Forging Machine

Heavy Construction and Latest Improvements

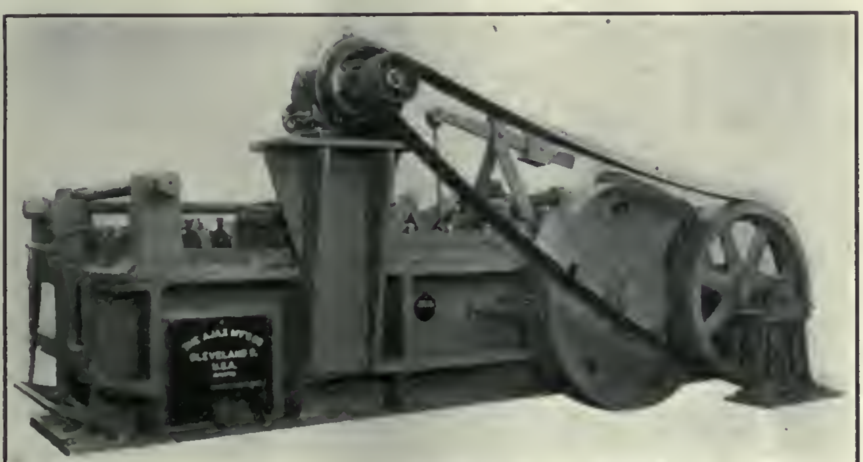
It is interesting to observe that as one of the effects of the extraordinary demand for heavy forgings during the war period our leading manufacturers have introduced many marked improvements in the heavier types of machines used in construction work. The steady increase in the use of alloy and high carbon steels in the forging industry has also aided in the demand for machines that will endure the increased strain of shaping these materials, and at the same increase the output and thereby aid in the natural desire for efficiency and economy. With a view to supplying this demands, the Ajax Manufacturing Company, Cleveland, Ohio, has perfected a new model upsetting forging machine of greatly increased strength and capacity, and embodying features entirely new in machines of this class.

While the main features that have characterized the machines built by the company have been retained, notably the positive die grip insured and protected by the breaker bolt in the safety knuckle, and are operated by means of the Ajax patented lock device which stops the dies in the wide open position and the header slide at the back of the stroke; the machines are approximately 40 per cent heavier than the old models. The new model 4-in. weighing 120,000 lbs., the 5-in. 155,000 lbs., and the other sizes in the same proportion, the increase in weight being distributed to strengthen and increase the size of all of the component parts. In the important matter of the slides, which are of the suspended type, the increase of weight has been considerable owing to their greater length. They are overhung on bronze faced bearings, readily lubricated, and entirely free from the possibility of accumulation of scale and other abrasive substances. The crank shafts have been nearly doubled in weight, and twin gear drive from pinion shaft to crank shaft is employed, giving equal torque to both ends of the crank pin, not only decreasing the strain but equalizing the strain at all points.

Other features, particularly the self-adjusting safety pitman, whereby the tendency to buckle is resisted up to a predetermined pressure adjusted by a heavy coil spring, and on reaching the desired pressure a latch jumps up, giving complete relief without the building up of additional pressure. On the return stroke the pitman straightens out, the latch drops into place and the machine is ready to go on with the work without any delay.



REAR VIEW—UPSETTING FORGING MACHINE SHOWING DRIVING GEARS, FLY WHEELS AND OUTBOARD BEARINGS.



NEW MODEL UPSETTING FORGING MACHINE.

Of the various materials used in the construction of those machines it may be briefly stated that they are all of the best, and the increase in their dimensions adapted to the requirements of the service demonstrated by long and varied experiments by expert engineers. An idea of the utility and capacity of these machines may be gathered from a test recently conducted at the company's plant. A 4-in. machine, at a single blow, forged a disc 9½ ins. in diameter and 1¼ ins. in thickness on the end of a 5½-in. bar of .60 carbon content, at a cherry red heat. In doing this severe work the machine gathered 8 ins. of stock and flattened it out with no tendency whatever to stalling in the operation. Many leading forging men have expressed their approving interest in the operation of these new model machines.

French Reconstruction Task.

The following facts regarding the magnitude of the reconstruction task confronting the French Minister of the Liberated Regions were given out by M. Labbe, Director General of the Technical Services.

Building work alone would require 22,000,000 tons of material and the labor of 700,000 people for one year; 100,000 houses are to be entirely rebuilt, requiring 5,000,000,000 bricks, 3,000,000 cubic meters of sand, 1,000,000 tons of lime, 13,000,000 square meters of tiles, and 3,000,000 cubic meters of wood. Reconstruction of highways and railroads would require 3,000,000 tons of materials and the labor of 15,000 men for one year. An addition of 20,000 trains and 5,000 trucks would be required.

The Tunnel Under the Selkirks.

A contract has been taken for lining the five-mile tunnel under the Selkirk Mountains on the Canadian Pacific Railroad with concrete. An extensive electric equipment is being installed for mixing the concrete. The electrification scheme by which the tuunel will be operated will do away with the smoke nuisance, so objectionable to passengers going through the mountain cut. It is also expected that the lining of concrete will eliminate the water seepage which has already caused so much trouble and expense.

Women in Railroad Service.

The latest official report shows that 81,803 women were engaged in railroad service. The maximum number during the war period was 101,785. The employment of women as laborers and other work rtquiring unusual physical strength has virtually ceased on railroads.

Q. & C. Company Extending.

The Q. & C. Company of New York has acquired by purchase the Everett Snow Melting Device, formerly manufactured by E. A. Everett, 123 Liberty street, New York.

Electrical Department

Facts on Important Electrifications—The Railroad Problem

A Few Interesting Facts on Important Railroad Electrifications.

Electrification works wonders in suburban service. The rapid accelleration of the multiple unit trains, combined with the rapid braking rate made possible by the clasp brake. and electric control of the air to the brake cylinders, gives increased schedule speeds and attracts riding. Engine movements are eliminated and the capacity of the tracks are increased.

One of the most noted examples of what electricity can do for suburban service is the electrification of the Philadelphia terminal of the Pennsylvania. The capacity of this station had been reached and something had to be done to change the terminal, for steam operation meant millions of dollars' expenditures. Electricity solved the problem.

The Philadelphia terminal has sixteen tracks, which narrows down to six, and all of the traffic in and out passes through this point. Nearly 600 trains are handled per day, and during the rush a train nearly every minute is dispatched by the congested point. The greatly increased capacity with the multiple unit electrification was accomplished by the reduction in the number of train movements incidental to electrification. The trains entering the terminal can remain. It is not necessary to pull the train out to release a steam engine at the head end and then push back again to be loaded. There are no engines moving in and out (i. e., as far as the electrified service is concerned —there are some through trains which call for special movements). It is interesting to know that these track movements per train turn-around has been reduced from six to two.

275-TON PASSENGER LOCOMOTIVE—CHICAGO, MILWAUKEE & ST. PAUL RAILROAD.

Period.	Total Car Mileage.	Total No. Detentions.	No. Miles per Detention.	Detention per 10,000 C. M.	Total Minutes.	Minutes Lost per 10,000 C. M.
January	242,872	3	80,957	0.124	29	1.194
February	223,752	4	55,938	0.179	14	0.626
March	244,224	5	48,845	0.205	20	0.817
April	244,636	4	61,159	0.168	35	1.022
May	252,216	5	50,443	0.198	14	0.555
June	235,222	7	33,603	0.297	45	1.91
July	228,705	4	57,176	0.175	45	1.968
August	216,322	4	54,080	0.185	11	0.508
Average	242,946	4.71	53,204	0.194	21.1	0.852

Included in Westinghouse electrification data is the following table, giving data on the multiple unit operation for the first eight months of the year 1919. It is very interesting and shows what remarkable service can be performed by electricity and the records are being constantly improved upon.

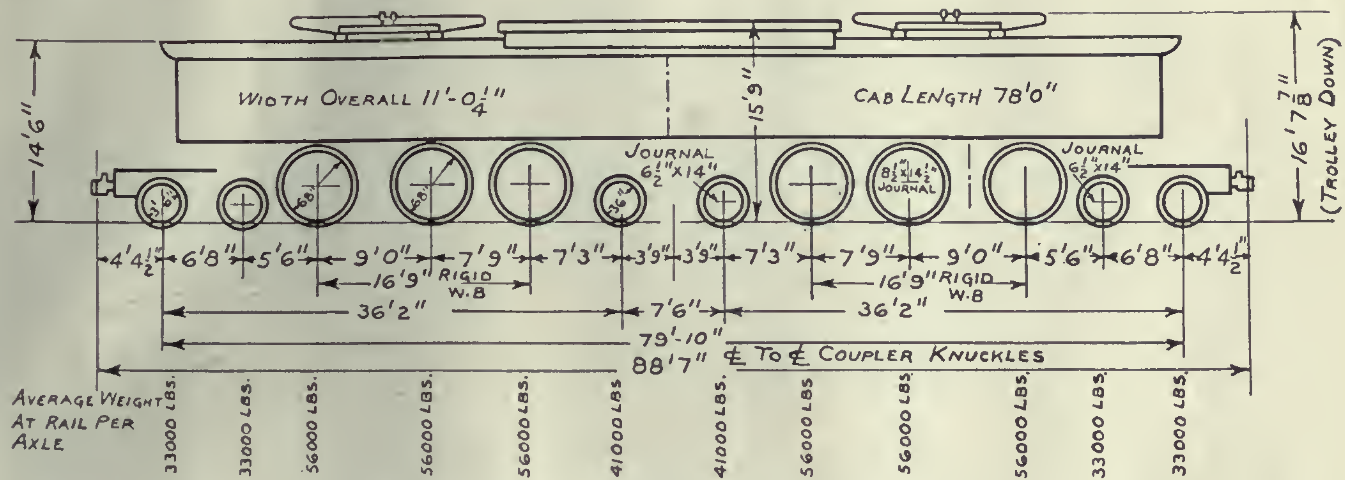
180-TON PASSENGER LOCOMOTIVE—NEW YORK, NEW HAVEN & HARTFORD RAILROAD.

Recently some very large and interesting electric locomotives have been put into service, namely, the giant locomotives for the Chicago, Milwaukee & St. Paul, weighing 275 tons each, and the 180-ton locomotives for the New Haven Railroad, built by the Westinghouse Company to haul a 900-ton train in express service and a 420-ton train in local service on both alternating and direct current. The New Haven locomotives, of which there are five, will run into the New York Terminal of the Pennsylvania over the Hell Gate bridge. The driving wheels are driven through gears and quills by six twin motors. We have included here the dimension outline, together with the rating of these locomotives.

RATING—FIVE NEW PASSENGER LOCOMOTIVES, NEW HAVEN R. R.

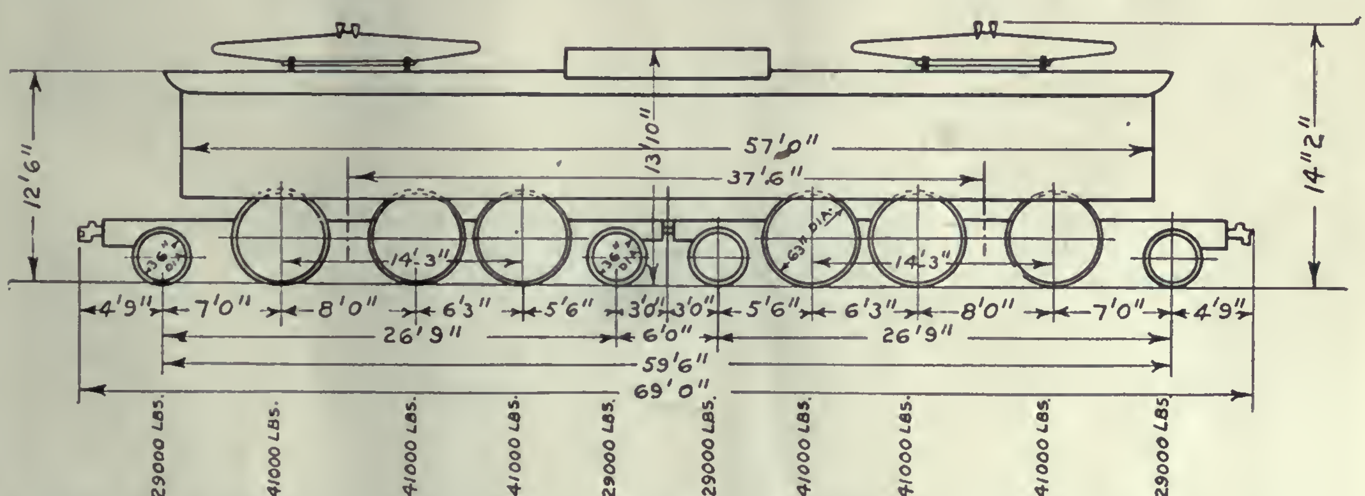
	T.E.	M.P.H.	H.P.
Continuous rating	14,500	44	1,700
One hour	21,000	36	2,000

The Milwaukee locomotives are equipped for operation on 3,000 volts direct current. There are ten of these, which are being built by the Westing-



DIMENSIONS AND WEIGHT DISTRIBUTION—275-TON PASSENGER LOCOMOTIVE—CHICAGO, MILWAUKEE & ST. PAUL R. R.

house Company, and the drive is similar to the New Haven. The locomotives will haul a 950-ton train over any of the electrified sections of the Chicago Milwaukee, which include 18 miles of average 2.2 per cent grade. The rating of this locomotive is as follows:



DIMENSIONS AND WEIGHT DISTRIBUTION—180-TON LOCOMOTIVE—NEW YORK, NEW HAVEN & HARTFORD RAILROAD.

RATING—C., M. & ST. PAUL, 275-TON PASSENGER LOCOMOTIVE.

Continuous rating	49,000	at 26	M.P.H.
" "	44,900	" 28.2	"
" "	40,800	" 30.4	"
One hour rating	66,000	at 23.8	M.P.H.
" "	61,500	" 25.5	"
" "	57,000	" 27.2	"

Railroad Electrification and the Railroad Problem

We know from the many electrifications that have been made in this country and abroad that electricity can perform every railroad service which has been previously done by steam, and even better. The electric locomotive is not a generator of power as is the steam locomotive. It is a transformer of energy. Electrical power is received and mechanical power delivered with an efficiency of approximately 80 per cent and sometimes better. The electric power house is of unlimited capacity compared to the electric locomotive, so that the power taken by each locomotive can be as much as desired and required. The electrical control of the locomotives permits multiple operation, and as many locomotives as may be needed can be coupled together and operated as one unit by one engineer from either cab. Large tractive effort can thus be secured in a combined unit and only one engine crew needed.

The electrifications already in operation have shown the steam railroad officials the possibilities of the electric locomotive. Unlimited motive power permits longer trains and higher schedule speeds. The heavy mountain grades are no longer the superintendent's nightmare. The handling of freight has been facilitated. Freight is the larger part of the railroad business. It produces 73 per cent of the revenue. What can be done with electricity in freight service can not be better illustrated than by referring to the Norfolk and Western electrification. The heavy coal trains of 3,500 tons are handled up the heavy grades at 14 m.p.h., twice the speed obtained with the same weight trains when handled by Mallet locomotives, and this service is performed by two electric locomotives instead of three Mallets.

Electricity opens up immense possibilities. In the West are available a great many waterpowers which will be utilized for electrification. Coal is getting rapidly scarce and of high cost, so that the railroads must turn to electrification as a means not only to increase traffic but to reduce costs.

The electrification of a railroad means a large investment in equipment and installation, and has thus proceeded slowly because the advantages were not appreciated to the point where they seemed to be worth the cost. To quote from a paper by Mr. Calvert Townley: "Electrification effects marked economies in "fuel, in maintenance, in labor and otherwise through a long list; but electrification calls for a heavy investment, and "unless these economies bulk large "enough, the interest on such investment "will wipe them out and turn the enterprise into a losing venture. I do not "believe the cause of electrification is "helped by undue optimism on the part "of its advocates. Rather should there "be an enlightened partisanship, enthusiastic where enthusiasm is justified, "but tinged with the sober conservatism "of the man who has to put his own "dollars to work.

"There are so many cases where electricity should be used, where its advantages are clear and conclusive, that "once the railroads escape from the "financial slough of despond in which "they are now wallowing and are again "able to get capital for their needs, there "will not be enough engineers, there will "not be enough electric factories in the "country to serve them. Every big system has need of electricity somewhere. "For some small roads it may mean the "difference between solvency and bankruptcy. I electrified a short derelict "line for the New Haven road between "Meriden and Middletown, long before "given over into the one-train-a-day-"annual-deficit class, and turned it into a "good earner.

"There can be no rule established. "Generalities are sure to be misleading, "but electrification is now firmly intrenched and successful. It is recognized by railroads generally as an effective agency with great possibilities and "one which is particularly valuable for "certain specific purposes. Time alone "will tell how broad its application is to "be, but I am confident we can await "developments with tranquillity, assured "that the art is in a healthy condition "and that progress will be along the "right lines."

The railroad problem is an important one to the whole nation. Mr. Samuel Rea, president of the Pennsylvania, has summed up the situation as follows:

"The railroad problem has not changed, "nor is it shrouded in mystery. It is "this: Railroad earnings and credit "must be created sufficient to support the "existing railroad investment and attract "the additional capital the transportation "business requires in the public interest. "New capital cannot be commandeered. "Therefore, adequate rates made under "public approval, with opportunity for "competition, initiative and incentive, is "the effective remedy for the whole problem in my opinion. If adequate rates "had been granted in the past decade, "there would not have been a railroad "problem. If public regulation does not "allow earnings sufficient to sustain railroad credit, and provide necessary "transportation facilities, the public will "be forced to regard regulation as a "huge waste of money, time and effort, "and demand a simplification of the situation, and start with a new slate, or "drive straight for Government ownership with its train of higher costs, "efficiency, and political domination of "the employes and of the industries depending on the railroads. National reconstruction cannot be accomplished "while railroad investments and credit "are left in an unsatisfactory condition. "This should spur Congress, the Commissions, the investors, the employes, "railroad management, and the public to "work together for the best results."

Tests of the Macfarlane Telephone System

Interesting Demonstration of Its Practicability

In our issues for February and May of 1918, articles were published descriptive of a telephonic apparatus designed by W. W. Macfarlane, whereby a conversation could be maintained between a station and a moving train, between two moving trains, between two cars or a car and the locomotive of the same train. A demonstration of the practicability of the accomplishment of this feat was recently made before a number of railroad men and representatives of the Bureau of Safety of the Interstate Commerce Commission at the Elkins Park station of the Philadelphia and Reading Railroad near Philadelphia, Pennsylvania. Two cars and a locomotive had been fitted with the apparatus, about four miles of track had been blocked off for the test and connections were made with the Elkins Park station, where an operator was stationed.

From the Elkins Park station a conversation could be readily carried on with men upon the cars or the locomotive, whether they were at rest or in motion. There was, however, some uncertainty as to the distinctness with which the speaker on the car or locomotive could be heard. At times the voice could be heard with amazing distinctness, rising even to that of a direct conversation, and as good as the best ever obtained in ordinary telephone service. Then, for reasons that were not explained or at present explic-

VIEW SHOWING INDUCTION COIL ON CAR.

able, the words would become blurred and indistinct or faint. One manifestation of this was particularly striking. The train was a little more than a mile away, and every word spoken on the car or locomotive could be heard with startling distinctness. Then, as the train approached, the voices became indistinct and faint until, when the train was moving slowly past the station, the tone was so low and faint as to be scarcely audible.

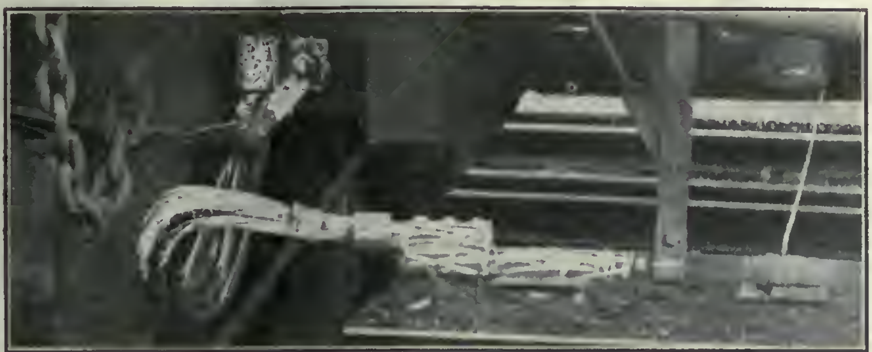
On the cars and locomotive the results were not so satisfactory.

On the car the speaker in the Elkins Park station could usually be heard. Sometimes rather indistinctly, so that the message had to be repeated several times, but still it could be heard.

On the locomotive there was great difficulty in hearing messages from the station, and the distinctness of the voice varied through wide ranges. Between the locomotive and the car there was more difficulty still. Frequently the message from locomotive to car had to be relayed by the station operator, and even greater difficulty was experienced in the transmission of messages from the car to the locomotive. On the car messages from the locomotive could be heard while the train was in motion, but the words were frequently so blurred as to be indistinct. But, when the train stopped the words immediately became quite as distinct as those of an ordinary telephone message.

Connections were also made between a standing car and a station on the regular Bell circuit without the receiver of the message from the car being aware that it came from any unusual source.

This demonstration, then, simply means that a principle of telephone operation has been found whereby it is possible to establish communication between the cars and locomotives of the same and different trains or between trains and fixed stations.



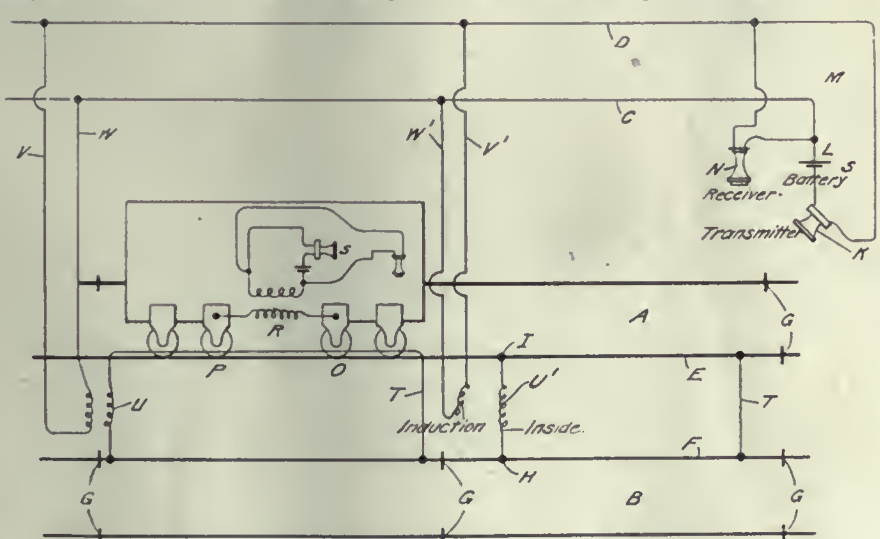
WHEEL CONNECTION OF MACFARLANE TELEPHONE SYSTEM.

That this first exhibition did not give perfect or, at times, even satisfactory results is not surprising. Indeed, it would have been most astonishing and unprecedented if it had. It simply means that here is a possibility of great promise and potentiality that should be worked out to full fruition.

In such a work of development many variables will be encountered and have to be worked out. At present only a suggestion of a few of the questions that may arise can be made, as, for example: Does the character of the road ballast have any influence on the transmission of telephonic messages? What is the influence of the difference in conductivity of different sizes of rail and qualities of steel used? What is the influence of the length of train in the transmission of messages between the caboose and the locomotive? What influence will an intervening train have on transmission between a train and a fixed station? And so changes might be sung on the problems to be solved to an almost indefinite extent. But in spite of the magnitude of the problem of development, the main essential fact has been established that it is possible to send telephonic messages between a moving or standing train and a fixed station, and between a car and locomotive on both moving and standing trains, which may be taken as the object of the demonstration referred to.

The apparatus as it stands is very simple. The transmitters and receivers are those in every day use in telephonic service and the special apparatus used is inexpensive and occupies but little space, as will be seen from the reproductions of photographs of that used in the Philadelphia and Reading demonstration.

The principle of action of the device is that of energizing the telephone circuit



WIRING DIAGRAM—MACFARLANE TELEPHONE SYSTEM.

by means of an induction and that is placed between the two adjoining rails of parallel tracks. The accompanying engraving gives a diagrammatic illustration of the wiring and circuits.

A and B represent the two tracks and E and F the two adjoining rails of the same. The insulation of the signal blocks is indicated by G. In each block there is an induction coil, the inside coil of which is connected to the two adjacent rails at H and J. There is also a simple tie between these two rails at T.

The terminals of the outside coil are tapped in to the two wires D and C, respectively, which are strung on the telegraph poles parallel to the track. These wires run to a fixed station M. The wire D runs through the transmitter K and the local battery L. The receiver N is in a line connecting the two parallel wires C and D.

The induction coils are located in each block.

The car equipment consists of a connection to a wheel in each truck at P and O, by which contact with the rail is secured and these two contacts are connected by one coil of an induction coil. The other coil is connected to a regular telephone circuit with a local battery in the circuit to the transmitter and directly through a receiver. Both being the ordinary telephone apparatus.

The method of operation is as follows: Words spoken into the transmitter energizes the induction coil R and the current from the secondary coil passes through the primary induction coil at U and completes its return circuit through T. The secondary coil at U, being thus energized, its current goes to C and D by way of the wires V and W, respectively. This telephone circuit returns to the rails in each block by way of the wires V and W, respectively, thus energizing the induction coil U and passes through the rails of each section or block from which any equipped vehicle in that block can pick it up and the words can be heard through the receiver on such a vehicle.

At the same time the message can be heard at the receiver N of the fixed station.

To communicate to a train from a fixed point, the wires D and C are energized from the local battery L. From these wires the current is carried through the wires V and W to the primary induction coil and thence through the inside secondary coil U to the rails, from which the current and words are picked up by the equipped vehicle on any block.

North-South Railway in Australia

The construction of another trans-continental railway to link Darwin in the north of Australia with the Southern States is being seriously discussed, chiefly by interested people in South Australia. The Minister for Home and Territories states that the matter of constructing the railway has been listed for cabinet consideration. The distance between Oodnadatta and the Katherine river is 1,026 miles, and this is the route that is being most strongly urged.

Automatic Train Control.

We recently called particular attention to the fact that not only is a reliable automatic train a great and growing necessity, but pointed out there there were already in operation several devices that were said to meet all of the requirements of the important problem, and only needed to be examined by the the proper authorities in order that a selection might be made and some definite action recommended to Congress for the adoption of the best device that may be available among the number that may be said to be in the experimental stage.

As far back as 1907 appropriations were made by Congress, and since that time examinations and tests have been conducted and reports have been made from time to time setting forth the results. Experiments and tests have also been conducted by several of the leading railroad companies, but the reports generally set forth that the apparatus coming under consideration has been far less substantial and rugged construction than modern signal and interlocking apparatus in common use, notwithstanding that the operating conditions and requirements are, generally speaking, more severe for train control than for signal devices.

The United States Railroad Administration appointed a committee last year to report upon the subject of automatic train control, their instructions were to examine the devices now undergoing tests upon various lines of railroad or available for test, and to make such recommendations for the installation and further practical test of any devices now or during their investigation made available for that purpose, which they may consider practical and reasonably conforming to the purposes to be desired.

The committee appointed were as follows: C. A. Morse, chief engineer, Chicago, Rock Island & Pacific; A. M. Burt, assistant director of division of operation, United States Railroad Administration; U. S. Balliet, assistant terminal manager, Grand Central Terminal, New York, N. Y.; R. W. Bell, general superintendent of motor power, Illinois Central; W. P. Boland, chief, Bureau of safety, Interstate Commerce Commission; C. E. Denney, assistant federal manager, New York, Chicago & St. Louis; J. H. Gumbes, general superintendent, Pennsylvania; Henry Bartlett, chief mechanical engineer, Boston & Maine; G. E. Ellis, secretary; E. L. Adams, signal engineer.

Since the appointment of the committee C. A. Morse has resigned and A. M. Burt is now chairman.

The following definitions and requisites for automatic train control have been adopted by the committee:

DEFINITION OF AUTOMATIC TRAIN CONTROL.

An installation so arranged that its operation automatically results in either one or the other or both of the following conditions:

First. The application of the brakes until the train has been brought to a stop.

Second. The application of the brakes when the speed of the train exceeds a prescribed rate and continued until the speed has been reduced to a predetermined rate.

REQUISITES FOR THE DESIGN AND CONSTRUCTION OF AUTOMATIC TRAIN-CONTROL DEVICES.

1. The apparatus so constructed as to operate in connection with a system of fixed, block, or interlocking signals, and so interconnected with the fixed signal system as to perform its intended function:

(a) In event of failure of the engineman to obey the fixed signal indications, and

(b) So far as possible, when the fixed signal fails to indicate a condition requiring an application of the brakes.

2. The apparatus so constructed that it will perform its intended function if an essential part fails or is removed; or a break, cross, ground, or failure of energy occurs in electric circuits when used.

3. The apparatus so constructed as to make indications of the fixed signal depend upon the operation of the track element of the train-control device.

4. The apparatus so constructed that proper operative relation between those parts along the roadway and those on the train will be assured under all conditions of speed, weather, wear, oscillation, and shock.

5. The apparatus so constructed as to prevent the release of the brakes after automatic application until the train has been brought to a stop, or its speed has been reduced to a predetermined rate, or the obstruction or other condition that caused the brake application has been removed.

6. The train apparatus so constructed that, when operated, it will make an application of the brakes sufficient to stop the train or control its speed.

7. The apparatus so constructed as not to interfere with the application of the brakes by the engineman's brake valve or to impair the efficiency of the air brake.

8. The apparatus so constructed that it may be applied so as to be operative when the engine is running forward or backward.

9. The apparatus so constructed that when two or more engines are coupled together, or a pusher is used, it can be made operative only on the engine from which the brakes are controlled.

10. The apparatus so constructed that it will operate under all weather conditions which permit train movements.

11. The apparatus so constructed as to conform to established clearances for equipment and structures.

12. The apparatus so constructed and installed that it will not constitute a source of danger to trainmen, other employes, or passengers.

After nearly a year of investigations as to the merits of existing devices the committee then reported at considerable length, the following being the condensed conclusions:

1. That the relative merits of the various types of automatic train control can not be determined until further tests have been made.

2. That more extended service tests, including complete records of performance, are necessary before a decision can be reached on the availability for general practical use of any of the devices that have been brought to the attention of the committee.

3. That on a large part of the railroad mileage in the United States, with a given amount of money available for protection purposes, a greater degree of safety can be obtained by installing block signals than by installing automatic train control devices.

4. That on lines of heavy traffic, fully equipped with automatic block signals, the use of train control devices is desirable.

5. That complying with its instructions and without implying indorsement, the committee finds the following devices available for further test:

American Railway Signal Co.—Intermittent electrical contact type.

American Train Control Co.—Intermittent electrical contact type.

Automatic Control Co.—Electrically controlled mechanical trip type.

Casale Safety Device Co.—Intermittent electrical contact type.

Clifford Automatic Train Stop Co.—Electrically controlled mechanical trip type.

General Railway Signal Co.—Intermittent electrical contact type.

General Railway Signal Co.—Inert roadside element.

International Signal Co.—Intermittent electrical contact type.

Miller Train Control Corporation—Intermittent electrical contact type.

National Safety Appliance Co.—Induction type.

Nevens-Wallace Train Control Co.—Electrically controlled mechanical trip type.

Schweyer Electric & Mfg. Co.—Inert roadside element.

Shadle Automatic Train Signal Co.—Intermittent electrical contact type.

Sprague Safety Control & Signal Corporation.—Induction type.

Union Switch & Signal Co.—Continuous induction type.

Wooding, B. F.—Intermittent electrical contact type.

Willson-Wright Safety Appliance Co.—Electrically controlled mechanical trip type.

Items of Personal Interest

W. S. Tasker has been appointed general roundhouse foreman of the Santa Fe, with office at Clovis, N. M.

A. T. Truswell has been appointed night roundhouse foreman of the Santa Fe, with office at Dodge City, Kan.

B. C. King has been appointed general boiler inspector on the Northern Pacific, with headquarters at St. Paul, Minn.

C. H. Koyle has been appointed engineer of water service on the Chicago, Milwaukee & St. Paul, with office at Chicago, Ill.

Alden Morgan has been appointed erecting shop foreman of the Erie at Huntington, Ind., succeeding P. F. Myers, resigned.

C. H. Wilcken has been appointed traveling engineer and trainmaster on the Denver & Rio Grande, with headquarters at Helper, Utah.

C. A. Pinyord, supervisor in the Chicago office of the Safety Car Heating & Lighting Company, New York, has been appointed sales representative.

L. J. Loehofer, night roundhouse foreman of the Santa Fe, at Vaughn, N. M., has been transferred to Clovis, N. M., succeeding C. R. Madsen, resigned.

D. L. Eubank, mechanical expert with the Galena Signal Oil Company, has been appointed district manager in charge of the Cincinnati office of the company.

G. W. Bergman, general foreman of the Detroit, Toledo & Ironton, at Jackson, Ohio, has been appointed superintendent of motive power, succeeding R. W. Tawse, resigned.

E. O. Smith, master mechanic on the St. Louis & Hannibal, at Hannibal, Mo., has been appointed master mechanic on the Louisiana & North West, with office at Homer, La.

H. F. Martyr, formerly general foreman of the Rock Island at Norton, Kan., has been appointed master mechanic of the St. Louis & Hannibal, with office at Hannibal, Mo.

W. W. Scott has resigned as general foreman of the Buffalo, Rochester & Pittsburgh, at Punxautawney, Pa., to take service with the Edna Brass Manufacturing Company of Cincinnati, Ohio.

F. K. Hutt, acting general master mechanic of the Missouri Pacific, with headquarters at St. Louis, Mo., has been appointed mechanical superintendent of the Missouri, Kansas & Texas, with office at Parsons, Kan.

H. Shoemaker, assistant storekeeper of the northern district of the Baltimore & Ohio, with headquarters at Cleveland, Ohio, has been appointed storekeeper at Mt. Clare, Baltimore, Md., succeeding F. E. Johnson.

F. C. Moeller, roundhouse foreman of the Chicago, Rock Island & Pacific at Blue Island, Ill., has been appointed general foreman in the locomotive department at Cedar Rapids at Cedar Rapids, Iowa, succeeding E. Mueller.

F. H. Maple, superintendent of the Point St. Charles, Que., plant of the Canadian Sheet Foundries, Montreal, Que., has been appointed foundry superintendent of the American Steel Foundries' plant at Alliance, Neb.

A. N. Lucas, superintendent of the locomotive shops of the Chicago, Milwaukee & St. Paul, with office at Milwaukee, Wis., has been appointed district manager of the Oxweld Railroad Service Company, with headquarters at Chicago, Ill.

Arthur Haller, formerly in charge of the publicity department of the American Locomotive Company, with offices at 30 Church Street, has been advanced to a position in the general sales department with headquarters in Chicago, Ill.

C. H. Judson, assistant valuation engineer of the New York Central Lines west of Buffalo, with office at Cleveland, Ohio, has been appointed assistant engineer in charge of the work in connection with Valuation Order, No. 3, for the lines west of Buffalo.

S. E. Mueller, general foreman in the locomotive department of the Chicago, Rock Island & Pacific, at Cedar Rapids, Iowa, has been appointed master mechanic of the Dakota division, with headquarters at Estherville, Iowa, succeeding R. J. McQuade, resigned.

C. M. Rogers, formerly inspector of tonnage rating and latterly supervisor of stationary plants on the Chicago, Rock Island & Pacific, has been appointed manager of service and sales for the Locomotive Firebox Company, with headquarters at Chicago, Ill.

Lieut. Col. H. C. Nutt, general manager of the Los Angeles & Salt Lake, at Los Angeles, Cal., has resigned to become president of the Central Equipment and Coal Commission which represents England, France and Italy, and has charge of all bituminous coal mining and distributing operations in Silesia.

Lieut. Vernon S. Henry, having been released from army service, has re-entered the service of the Safety Car Heating & Lighting Company, New York. During the war period Mr. Henry was in charge of the development of machine gun and anti-aircraft material, and was warmly commended for meritorious service.

R. G. Bennett, master mechanic of the Pennsylvania at Pittsburgh, Pa., has been appointed superintendent of motive power of the central division, with headquarters at Williamsport, Pa., succeeding E. W. Smith. Mr. Bennett was a graduate of Purdue University in 1908, and in the same year was appointed motive power inspector on the Monongahela division of the Pennsylvania. In 1916 he accepted the appointment as master mechanic in the Cumberland Valley railroad, but again took service with the Pennsylvania, and in 1917 was appointed master mechanic at Pittsburgh, as above noted. F. S. Robbins has been appointed master mechanic of the Pennsylvania, succeeding Mr. Bennett.

Alexander Taylor, for many years Manager of Works, has been made Assistant to Vice-President in general charge in all plants of production, stocks and stores of the Westinghouse Electric & Manufacturing Company; R. L. Wilson has been promoted from position of General Superintendent to Works Manager of the East Pittsburgh Works; E. R. Norris has been appointed Director of Works Equipment, in charge of machinery, tools and methods in the various plants; C. B. Auel is made Manager of the Employees' Service Department; G. M. Eaton has been made Chief Mechanical Engineer of the Company; C. W. Johnson and H. W. Cope, Assistant Directors of Engineering; C. H. Champlain and E. S. McClelland, Assistant Works Managers; John E. Bonham, Assistant to Works Manager; E. S. Brandt, Supervisor of Equipment and Methods. The following were appointed as Managers of the engineering departments indicated: A. M. Dudley, Automobile Equipment; R. P. Jackson, Material and Process; F. E. Wynne, Railway Equipment Department; and G. H. Garcelon, Small Motor.

Obituary.

Edward Payson Ripley.

Edward Payson Ripley, chairman of the board of directors of the Santa Fe railroad system, died at Santa Barbara, Cal., on February 4, 1920. Mr. Ripley was born at Dorchester, Mass., in 1845, and entered railroad service in 1868 as a clerk in the Boston office of the Pennsylvania Railroad. In 1870 he became attached to the Chicago, Burlington & Quincy, and rose rapidly to the position of general manager. In 1890 he was elected third vice-president of the Chicago, Milwaukee & St. Paul Railroad. In 1896 he was made president of the

Atchison, Topeka & Santa Fe Railroad, which position he resigned last year, but remained in the service of the road as chairman of the board of directors until his death. During Mr. Ripley's incumbency as president of the road he introduced vast improvements, and in the department of railroad operation generally he was regarded as a leader in the front rank of the railroad men of our time. He was a strong and forceful character, an able writer and speaker, polished by eastern education and broadened by western experience. He possessed rare executive ability, and was held in the highest regard by the railroad employes, in whose welfare he had a warm and abiding interest.

John C. Barber

The death is announced of John C. Barber, founder and president of the Standard Car Truck Company, Chicago, Ill. Mr. Barber was in his seventy-sixth year, and was a veteran of the civil war. At the age of twenty-one he entered railway service and had an extensive experience in locomotive and car building. He was the inventor of many improvements, particularly in railway truck appliances, and filled many official positions, chiefly in the car departments of the leading western railroads. In 1896 he resigned the position of superintendent of the car department of the Northern Pacific at St. Paul, Minn., and organized the Standard Car Truck Company, devoting his attention to perfecting and marketing his inventions for lateral roller motion trucks, and was president of the company for nearly twenty-five years.

Evarts Shankin Barnum.

Evarts Shankin Barnum, of the G. M. Basford Company, died at his home in Ridgewood, N. J., on February 3, after an illness of eight days. Mr. Barnum was born in Louisville, Kentucky, in 1883, and received his education at Purdue University, graduating in 1906. His entire business life was connected with railroad work. Immediately upon his graduation from college he entered the service of the Pennsylvania Lines West as apprentice, and worked successively as apprentice, machinist, foreman, general foreman, roundhouse foreman and motive power inspector. Leaving the railroad in 1917, he joined the staff of the *Railway Age* as associate editor, and later became associated with the G. M. Basford Company, in charge of the copy department.

Mr. Barnum endeared himself to all with whom he came in contact. His even and pleasing disposition and his desire to "help the other fellow" made a friend of everyone he met. Mr. Barnum is survived by his wife and two children.

Domestic Exports from the United States by Countries, During December, 1919.

STEAM LOCOMOTIVES.

Countries.	Number.	Dollars.
Germany	12	550,280
Norway	2	79,360
Russia in Europe	20	900,000
British Honduras	1	13,000
Canada	12	159,406
Guatemala	1	10,100
Mexico	2	10,085
Jamaica	2	71,180
Cuba	36	945,569
Dominican Republic	3	75,130
Colombia	1	19,500
New Zealand	2	29,410
Philippine Islands	1	11,500
French Africa	1	17,562
Total	96	2,892,082

Return of Railroads Under Way.

Actual relinquishment of Government control over railroad operations has begun. Car records have been kept during February, and traffic is being given to and routed over as far as possible by the original owners. By the beginning of March it is expected that the operation of the carriers will be back to a comparatively simple basis, though representatives of many of the railroads feel that they never will recover traffic directed to other lines by the Government.

Director General Hines will, it is believed, continue in that office for some time after the actual relinquishment of the lines, to make settlements with the various corporations. Most of the 1,200 employes of the Railroad Administration will be released from further service early in March.

The Transportation Question.

Seth Mann, traffic manager of the San Francisco Chamber of Commerce, says that the first year after the return of the railroads to private control will be one filled with difficulties and obstacles to be met by the private carriers. It may be fairly anticipated that for at least a year they may not be able to furnish a transportation service equal in efficiency to the Government service. The public should be prepared for this emergency, and the carriers should adopt a new attitude toward the public which will keep them informed of existing conditions. Competition in service produced in the past a better service than the Railroad Administration has been able to give. It remains to be seen whether the private owners can excel the Government administration in the future. The shippers of freight are convinced that the dangers of public control far exceed any disadvantages attaching to lack of uniform or consolidated operation under private management. On the other hand, they look forward to the return of competition and the control of the various systems of railroads by the respective private organizations of expert railroad managers as an immediate solution of the transportation question.

Snow-bound Railroads.

The heavy snow storm during the early part of February disarranged traffic on many of the leading railroads. Complaints were mostly from the Eastern States, some parts of New York State and New England reporting drifts from ten to fifteen feet deep. An unusual occurrence was the entire stoppage of the electric system on the Long Island railroad, steam engines being called into the service. The inability to secure sufficient labor forces to assist in digging out the stalled trains contributed to aggravate the delay. This was especially the case on the New York Central, the epidemic of influenza adding to the shortage of men available for duty.

Mr. Willard on the Railroads.

Daniel Willard, president of the Baltimore & Ohio railroad, and one of the country's recognized experts on railway economics, says: "In my opinion, the railroads under private ownership and operation will furnish this country with adequate transportation by rail at a lower cost to the public man than would be the case under Government ownership and operation. I am assuming, of course, that it will be understood that the total cost of operation must be paid by the public, whether it be paid through rates and charges applied to each individual service performed or partly through rates and charges and partly through funds taken from the public treasury and raised through the means of general taxation."

Discipline.

General Atterbury, speaking recently, said of the matter of discipline: "The French, and the Germans, too, for that matter, are much more highly disciplined than our Americans; they have greater respect for laws and regulations. As you know, it is the breaking of the rules of our American railroads that is so often the cause of our accidents."

Among the valuable assets of the war are the object lessons which America has both given and received in her intimate contact, man to man, with the peoples of the older races from which we have sprung. Respect for law and order, as exemplified in the precepts and life of the parents, and the enforcement of penalties for disobedience on the children—here is a lesson which, if laid to heart and applied, will go far to offset the sacrifices we have made.

BOOKS, BULLETINS, ETC.

Proceedings of the Twenty-seventh Annual Convention of the Traveling Engineers' Association. Edited by W. O. Thompson, secretary, Cleveland, Ohio. 366 pages.

The published proceedings of the Traveling Engineers' Association have always been a valuable addition to railroad literature, and the record of the transactions of the convention held at Chicago, Ill., on September 16-20, 1920, worthily maintains the records of past achievements. Of special value are the debates on the various questions arising out of the problems presented affecting air brakes. Coming from real practical men, whose work brings them in contact with the operation of the appliances whereof they speak, they may properly be said to be the last words in air brake deta'ls. The same may be said of the taking care of locomotives at terminals, upon which much valuable information was furnished, all aiming towards improvement in railroad service. From the secretary's report it appears that there are now 1,297 members, an increase of over 200 during the year. Copies of the book may be had on application to the secretary.

The Tech Engineering News.

The undergraduates of the Massachusetts Institute of Technology have begun the publication of an engineering journal which gives promise of a new departure in collegiate journalism. Its aim is to establish a vehicle for the interchange of opinions among the graduates and undergraduates in regard to anything that they may encounter in their chosen callings, and which it would be well to be known to others. The paper starts in the right direction, and it is to be hoped that it will keep aloof from recording the social pastimes so common to college journals. While it is not likely that foot ball or base ball wil receive the same legislative treatments that "highballs" have received, there should be no place in a journal devoted to the interchange of opinions on engineering subjects for school boy sports, however beneficial they may be in the development of mere muscular activity. The paper is in no sense competing with professional and trade journals any more than it is competing with the daily newspapers. It is purely educational in its aim, and its editors and contributors will aid in leading the young student, and others not so young, to a keener interest in the real work of life, and the cultivation of a clearer expression of the means and methods of widening the realm of enduring accomplishment. The paper extends to 16 pages, and is finely printed on toned paper. It will be published monthly at Cambridge, Mass.

Accident Bulletin No. 71.

The Bureau of Statistics of the Interstate Commerce Commission are evidently making an effort to catch up with their work. Usually about two years elapsed between the date of the matter referred to in the reports and the date of issue. The present issue records the collisions, derailments and other accidents resulting in injury to persons and to equipment from the operation of railways in the first three months of 1919, so that the reports are now within a year of the happenings of the matter recorded. In comparison with the record of the previous three months the safety movement grows slowly but surely, the last three months of 1918 showing a list of fatalities by railroad accident of 2,371 and injured 18,875. In the first quarter of 1919 the record is 2,213 killed, and 17,527 injured, a gain in safety of over 6 per cent. In the list of trespassers killed 810 were reported in the period referred to 1918, and 578 injured. In the 1919 period the record shows 1,061 trespassers killed and 941 injured. The accidents at highway grade crossings continues to show as formerly that trains striking or being struck by automobiles results in more casualities than the gross number occurring to pedestrians, trolley cars and other vehicles. Of 314 fatalities at railroad crossings, 178 are caused by collisions with automobiles.

Iron and Copper.

The Bureau of Mines of the Department of the Interior has issued an interesting report on the iron and copper industry showing an increased activity in these industries in the United States. During December the pig iron output increased some 10 per cent in spite of the coal and steel strikes which were expected to affect the output. Total results for the past year indicate that approximately 30,500,000 tons of coke and anthracite pig iron were produced as compared to 38,506,000 tons in 1918. New furnaces are being continually brought into operation so that now over 60 per cent of the stacks in the United States are running. It is significant that the daily tonnage of the blast furnaces, after steadily declining in the early part of 1919, rallying in the summer and decreasing in the fall, is now increasing again.

In regard to copper, statistics show that the United States produces about 60 per cent of the world's copper supply, but of all the world's mines it has been estimated that 69 per cent of their output comes financially, under American control. It is a well-known fact that the world is dependent upon the United States for most of its copper, and that the mines in this country have dominated the world's output. The greatest copper deposits lie in the western hemisphere, North and South America together accounting for about three-quarters of the world's supply of copper.

Railway Artillery.

Major J. K. Meneely, in the *Journal of the U. S. Artillery* describes a new method of switching railway artillery on to a siding, which can be accomplished in half an hour's interruption of the main line traffic. The method is applicable to every kind and type of gun from 16 ins. to 7 ins. It has usually taken over four hours to accomplish the moving of artillery to a siding, and Major Meneely's improved method is one of the lessons learned in actual service in the recent war.

Motor Transport Resources.

G. B. Clarkson, Director of the United States Council of National Defense, by authority of the Secretary of War, has communicated with the governors of the various States requesting that they take steps for mobilizing the motor transport resources within each State to the end of using highways transport wherever necessary or advisable in any emergency. The responses of the governors have been prompt and satisfactory.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXIII 114 Liberty Street, New York, March, 1920 No. 3

Russian Decapod Locomotives

Details of Their Construction and Material

Some time ago an order was placed for 200 locomotives of the decapod 2-10-0 type for the Russian railways. These were built in accordance with the specifications and designs of A. I. Lipetz, chief of the locomotive division of the Russian Mission on Ways and Communication. The engines were built by the Baldwin Locomotive Works and the American Locomotive Co., but owing to the disturbances in Russia they have not been delivered, but have been distributed among a number of railroads in this country. In general design they follow American practice, but are equipped with many details that were worked out in accordance with Russian standards.

One of the novelties, in so far as Russian practice is concerned, is the use of a considerable number of Tate flexible staybolts in the side, crown and throat sheets, as well as the substitution of steel for copper in the fire boxes. The use of flexible bolts has been confined to the so-called breaking zone, and is far from being a complete installation. There were 462 flexible bolts used in all, of which 286 were placed in the sides. This gave two rows across the top and down the sides with a cluster in the upper corners. There was a complete installation in the throat sheet and 84 in the back head. In addition to this there were four rows of expansion stays to carry the front and one to carry the back end of the crown sheet. The boiler was of the straight top type with a wide firebox set above the rear drivers and having a grate area of nearly 65 sq. ft., which is very large for Russian practice. The dome is 30 in. in diameter and of the built-up type. As will be seen from the photograph it is much higher than the present American practice will permit. With this height it is possible to use a set of baffle plates for drying the steam that have proven very efficient; and, by delivering dry steam to the throttle has greatly increased the efficiency of the superheater. The baffle plates consist of a tube above the top of which is a plate with a downwardly projecting flange that comes down on the outside of the tube, which is 21½ ins. in diameter, with a space of 12½ ins. between. The steam is thus obliged to make two turns of 180° each in rising to the throttle chamber. The contained moisture is, therefore, precipitated and falls back into the boiler.

The throttle valve is of the slide valve type working against a vertical face, and is provided with a small pilot valve which, by a preliminary opening, relieves the pressure on the back of the main valve and permits it to be easily moved. The exhaust nozzle is variable and the variation in its diameter is accomplished by means of a hollow frustum of a cone that can be raised or lowered thus reducing or increasing the area of the exhaust.

DECAPOD 2-10-0 TYPE LOCOMOTIVE FOR THE RUSSIAN GOVERNMENT RAILWAYS.
Baldwin Locomotive Works, Builders.

There is a bypass valve on the cylinders which is of very simple and effective construction. It consists of a 4-in. connection between the two parts of the cylinder in which there is placed a cylinder, set at right angles to the connection, which carries a piston and guide which are held down by a spring. When the throttle is opened steam is admitted beneath the piston and forces it up to close the opening in the by-pass connection.

When the steam is shut off the spring forces the piston down leaving a clear 4-in. opening between the two ends of the cylinder.

The frames are vanadium steel castings 4½ ins. wide. The equalization is anchored to the frames between the third and fourth pair of drivers, but is so arranged that it can be changed and anchored between the second and third pair.

The driving wheel centers are tired to metric measurements, and the tire widths and transverse spring also conform to the metric system.

Screw couplers and spring buffers are applied in accordance with the Russian practice. The equipment also includes the Russian Westinghouse automatic air brakes, Le Chatelier cylinder water brakes, electro pyrometer for indicating the temperature of superheated steam and a six-feed mechanical lubricator.

The following is a list of the principal dimensions of these locomotives:

Cylinder diameter, 25 ins.

Piston stroke, 28 ins.

Piston valves diameter, 12 ins.

Type of boiler.—Straight top.

Inside diameter of shell, 5 ft. 9 ins.

Thickness of sheets, 21/32 in.

Steam pressure.—180 lbs. per sq. in.

Fuel.—Soft coal.

Method of staying—Radial.

Material of firebox—Steel.

Length of firebox, 108 ins.; width, 86¼ ins.; depth, front, 76¼ ins.; depth, back, 67¼ ins.

Thickness of sheets, side, ⅜-in.; back, ⅜-in.; crownsheet, ⅜-in.; tubesheet, ⅝-in.

Width of all water spaces, 4 ins.

Tubes diameter, 5⅜ ins. and 2 ins.

Material of tubes, steel.

Tubes, thickness, 5⅜ ins. No. 9 W. G.; thickness, 2 ins., No. 11 W. G.; 5⅜ ins., No. 28 W. G.; 2 ins., No. 194 W. G.; length, 17 ft.

Heating surface, firebox, 200 sq. ft.; tubes, 2,380 sq. ft.; firebrick tubes, 27 sq. ft.; total, 2,607 sq. ft.; superheater, 579 sq. ft.

Grate area, 64.7 sq. ft.

Driving wheels diameter, outside, 52 ins.; center, 1m. 170.

Main journals, 10½ ins. x 12 ins. other journals, 8½ ins. x 12 ins.

Truck wheels diameter, 33 ins.; journals, 6 ins. x 12 ins.

Wheel base, driving, 18 ft. 8 ins.; rigid, 18 ft. 8 ins.; total, 27 ft. 10 in.; engine and tender, 60 ft. 3½ ins.

Weight on driving wheels, 177,000 lbs.; truck wheels, 23,000 lbs.; total of engine, 200,000 lbs.; total engine and tender, 334,800.

Tender wheels, number, 8; diameter, 36 ins.; journals, 5½ ins. x 10 ins.; tank capacity, 7,400 U. S. gals.; fuel capacity, 8 metric tons.

Service, freight.

From Ocean to Ocean

The Canadian Pacific Railway, with its 13,388 miles of track in operation, is of surpassing magnitude not only in its amazing development, starting as it did in 1887 with 2,904 miles of track from Montreal to Vancouver, thus opening up a hitherto unexplored domain, but in the construction and accumulation of multitudinous branches forming a network of railways between the Atlantic and Pacific oceans that marks it as preeminent in territorial domain. At the first glance the enterprise seems stupendous, but no other railway had such advantages. Twenty-five millions of acres of land were granted to the company by the Canadian government. This has been added to and subtracted from by subsequent legislative enactments, but it still remains a mighty empire, beside which some of the European monarchies or republics, or whatever they are, would look small. Not only this, but the Pacific ocean is dotted with its fleets of ships following each other forward and backward to China and Japan, and calling in at San Francisco.

MT. STEPHEN AND FIELD, BRITISH COLUMBIA.

In point of scenic interest it embraces all the varieties of the north temperate zone, and, as may be expected, is a great favorite with tourists. Last year the passenger traffic reached enormous proportions, and the coming season bids fair to maintain the high record, although the battlefields of France may be said to be now open to the wealthy seekers after something new. To those who have an eye for scenic splendors there is no need of going to the Alps. The Rockies, the Sierras, and the Selkirks have them, figuratively speaking, frozen stiff, while the mere physical comforts possible in modern transportation have reached such a degree of sumptuous elegance on the American railways that, judging by the slow degree of progress in that direction in European railways, it will take at least a century before they can catch up with the point where American railways now are.

Abstract of the Interstate Commerce Act

Terminating Federal Control of the Railroads

The control of the railroads by the Federal government has come to an end, and the railroads are returned to their owners as originally agreed when they were taken over by the government. That their control by the Federal authorities during a great national emergency was a measure arising from the necessity of the situation is universally conceded, and the rapidity with which the troops and munitions were moved, and which would not have been so successfully accomplished under private control goes without question. The experience has been a great object lesson to both the government and the owners, a lesson which we hope will be of lasting value. The approach that has been made to a fuller standardization of equipment, to a more prompt and liberal treatment of the involved question of varying rates, are real advances in the right direction, and while it would be impossible to frame any kind of measure that would give general satisfaction to all concerned, it should not be assumed that perfection in detail can be accomplished without a fair trial, and, doubtless, the same spirit of compromise will be maintained in the future looking towards the improvement of the measure to the end that a spirit of progress may be encouraged, and a continued development of the railroad systems of the country may be maintained in the welfare of the promoters and shippers generally, and the common people particularly.

DEFICIT

Coming to the various details of the measure, it is gratifying to note that in the matter of any deficit that may have accrued to the roads during the period of Federal control shall be carefully computed on the basis of the transactions occurring during the three years ending June 30, 1917, and such deficit, if any, shall be placed to the credit of the roads, and just compensation made, including interest, taxes and other corporate charges and expenses. On the other hand, should the difference between the carrier's Federal control return, if an income, and its test period return, if a smaller income, or the difference between its test period return, if a deficit, and its Federal control return, if a small deficit, or the sum of its Federal control return, if an income, plus its test period return, if a deficit. The sum of such amounts shall be credited to the United States.

RATES

The rates, fares and charges, and all classification regulations and practices which were in force prior to March 1, 1920, shall remain in effect until September 1, 1920, and no change of any kind shall be made to reduce any rates or other charges, unless any such reduction or change is approved by the Interstate Commerce Commission. Loans may be granted to any railroad, the application for such loans meeting the approval of the Commission, the time not exceeding five years from the making of the loan, within which it is to be repaid, the loan bearing six per cent per annum.

ADJUSTMENT BOARDS

One of the most important clauses of the bill provides for the establishment of Railroad Boards of Adjustment, which may be established by agreement between any carrier, group of carriers, or the carriers as a whole, and any employees or subordinate officials or carriers, or organizations, or group of organizations thereof. Each adjustment board shall upon the application of the chief executive of any carrier or organization of employees or subordinate officials directly interested in the dispute, or upon the written petition of 100 unorganized employees or subordinate officials interested in the dispute, or upon the adjustment board's own motion, or upon the request of the Labor Board which shall have been appointed by the President of the United States, whenever such adjustment board or Labor Board is of opinion that the dispute is likely substantially to interrupt commerce, receive for hearing, and as soon as practicable and with due diligence decide, any dispute involving only grievances, rules or working conditions between the carriers and its employees or subordinate officials, who are, or any organization thereof which is represented upon any such adjustment board.

THE LABOR BOARD

The Labor Board shall be composed of nine members, three constituting the labor group, representing the employees and subordinate officials of the carriers, three representing the carriers, and three constituting the public group. The President shall make the appointments by and with the advice and consent of the Senate, the labor group and carriers each having the right to submit the names of six nominees from which the three representatives shall be chosen.

The Labor Board shall hear and as soon as practicable and with due diligence decide, any dispute in regard to which the adjustment board has failed or will fail to reach a decision within a reasonable time. The Labor Board has also the right to suspend the operation of its own decision when it involves such an increase in wages or salaries as will be likely to necessitate a substantial readjustment of the rates of any carrier, and as soon as practicable decide to affirm or modify such suspended decision. In all decisions at least one of the representatives of the public shall concur in such decision, a majority of the entire Board of nine members being necessary in a decision.

In arriving at decisions the Labor Board and all boards of adjustment shall establish rates of wages and salaries and standards of working conditions based among other relevant circumstances on the scales of wages paid for similar kinds of work in other industries; the relation between wages and the cost of living; the hazards of the employment; the training and skill required; the degree of responsibility; the character and regularity of the employment; and inequalities of increases in wages or of treatment, the result of previous wage orders or adjustments. The central offices of the Labor Board shall be maintained in Chicago, Ill., but meetings may be held at such other places as the Board may determine; and among its other duties shall be the publishing, from time to time, data and information in order that the members of the adjustment boards and the public may be properly informed, such publication to be issued at least once a year.

RATE OF WAGES

From March 1, 1920, to September 1, 1920, each carrier shall pay to each employee or subordinate official thereof wages or salary at a rate not less than that fixed by the decision of any agency, or railway board of adjustment in connection therewith. A penalty of $100 for each offense shall be imposed for any violation of this section of the bill.

LOCOMOTIVE AND CAR SERVICE

Whenever the Commission is of opinion that shortage of equipment, congestion of traffic, or other emergency arises requiring immediate action, it may, without notice, suspend the operation of all rules, regulations, or practices established with respect to car service for such time as may be determined by the Commission, to make such just and reasonable directions with respect to car service without regard to the ownership as between carriers of locomotives, cars, and other vehicles during such emergency as in its opinion will best promote the service in the interest of the public and the commerce of the people, and to require such joint or common use of terminals, including main-line track, and appoint such agents or agencies as the Commission shall designate and appoint for the purpose of meeting such emergency for such periods of time as the Commission may determine.

EXTENSION AND ABANDONMENT OF RAILROADS

The Commission shall also have authority to receive and act upon all petitions for extending the construction of new railroads or branches, or the abandonment of existing lines as circumstances in localities may arise, but its jurisdiction shall not extend to the construction or abandonment of spur, industrial, team, switching or side tracks, located or to be located wholly within one state, which are not operated as a part or parts of a general steam railroad system of transportation

REBATES AND CHARGES

All rebates of whatever form or kind are unlawful, and no carrier shall deliver or relinquish possession at destination of any freight transported to it until all tariff rates and charges therein have been paid, except under such rules and regulations as the Commission may from time to time prescribe to assure such prompt payment of all such rates, provided, that the provisions of this paragraph shall not be construed to prohibit any carrier from extending credit in connection with rates and charges on freight transported to the United States.

CONSOLIDATION OF RAILROADS

The Commission shall from time to time as soon as practicable adopt a plan for the consolidation of the railway properties of the Continental United States into a limited number of systems. In the division competition shall be preserved as fully as possible. Full hearings will be given to all who object to such consolidations, and after settlement the subject may be reopened at any time. The value of the properties shall be ascertained by the Commission, and shall not exceed their actual value. The same authority is vested in the Commission in regard to the consolidation of four express companies into the American Railway Express Company, and also for the maintenance, protection and operation of the Panama Canal Zone. Track or tracks leading towards docks are also placed under the authority of the Commission, as well as the right to establish any route, classification, or any rate, fare, or charge when the transportation is wholly by water. During the two years beginning March 1, 1920, the Commission shall take as such fair return a sum equal to 5½ per cent of such aggregate value, but may, in its discretion, add thereto a sum not exceeding one-half of one per cent of such aggregate value to make provision in whole or in part for improvements, betterments or equipment, which according to accounting system prescribed by the Commission, are chargeable to capital account.

EXCESS INCOME

Any carrier receiving for any year a net railway operating income in excess of 6 per cent of the value of the railway property held for and used by it in the service of transportation, shall place one-half of such excess in a reserve fund established and maintained by such carrier, and the remaining one-half shall be recoverable by and paid to the Commission for the purpose of establishing and maintaining a general railroad contingent fund. Carriers may draw from the reserve fund to the extent that its net railway operating income for any year is less than a sum equal to 6 per cent of the value of the railway property held for and used by it in the service of transportation, but such fund shall not be drawn upon for any other purpose.

ENLARGED COMMISSION

The Interstate Commerce Commission shall consist of eleven members, with terms of seven years, and shall be appointed by the President, by and with the advice and consent of the Senate. Not more than six members shall be appointed from the same political party. The term of the present nine commissioners or of any successor appointed to fill a vacancy, shall expire as heretofore provided by law. The two additional commissioners shall be appointed, one for a term expiring December 31, 1923, and one for a term expiring December 31, 1924

AUTOMATIC TRAIN CONTROL

The Commission, may after investigation, order any carrier by railroad, within a time specified by the order, to install automatic train-stop or train-control devices or other safety devices, upon the whole or any part of its railroad, such order to be issued and published at least two years before the date specified for its fulfillment. A carrier shall not be held to be negligible because of its failure to install such devices upon a portion of its railroad not included in the order; and any action arising because of an accident happening upon such portion of its railroad shall be determined without consideration of the use of such devices upon another portion of its railroad.

Baldwin Internal Combustion Locomotives

Their Growing Popularity in Contracting Operations, Railroad Yards, Plantations, Lumber Mills and Smelting Plants

The design of the Baldwin internal combustion locomotives have recently been revised without, however, modifying the general principles of construction. Various changes and improvements have been made, based upon the wide experience gained with the earlier locomotives which were simple in construction and followed steam locomotive design where practicable. These locomotives, built in accordance with patents granted to A. H. Ehle, have been in successful operation for the last ten years. They are particularly adapted for work in contracting operations, plantations, quarries, brick yards, lumber mills, smelting plants, switching in railroad yards, and other classes of service where loads are to be hauled at moderate speeds. Their radius of operation is limited only to the capacity of the attached fuel tank. They are also well adapted to conditions where the cost of coal or electricity would make either steam or electric locomotives an expensive, if not a prohibitive investment.

The accompanying drawing shows the general arrangement of the heavier type of these internal combustion locomotives. The four and six-wheeled types weigh from 5, 7½ to 10 and 15 to 25 tons, and cover a range sufficient to meet the requirements of average industrial service. The heavier types are well fitted for switching in railroad yards and terminals. The revised designs represent the most efficient line of internal combustion locomotives in service today.

The engine is vertical, and drives a small bevel pinion, placed at the opposite end of the shaft, either directly or through a system of auxiliary change speed gears. The small bevel pinion is constantly in mesh with two large bevel gears located on the top transverse counter-shaft. With the engine flywheel friction clutch engaged and driving either directly or indirectly through the auxiliary change-speed gears, the large bevels will, of course, run in opposite directions. These bevels run loose on the intermediate shaft except where one or the other is engaged by a forward and reverse jaw clutch located midway between the bevel gears. This construction is simple, yet positive, and provides for the operation of the locomotive in either direction.

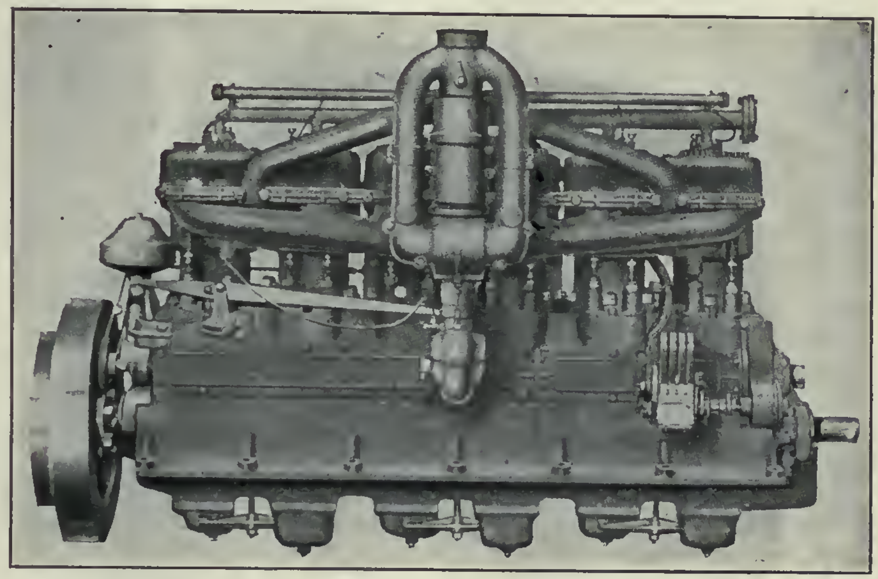
Two spur gears of different diameters are keyed fast to the top transverse counter-shaft, and these gears are constantly in mesh with corresponding intermediate and high-speed gears located on the jack or driving shaft, directly under the top transverse counter-shaft. These change speed gears, either without or in combination with the auxiliary change speed gears previously mentioned, permit the selection of four speeds in either direction. The engines are water-cooled, built for extremely heavy duty, and are of the four-cycle, four and six-cylinder type, the four-cylinder being used on the 5, 7½ and 10-ton sizes, and the six-cylinder on the 15 and 25-ton sizes. Lubrication is effected by a mechanical force-feed oiler, combined with splash in the crank case.

The 10, 15 and 25-ton sizes have the cylinders cast separately, four being used in the 10-ton size and six in each of the other two. The cylinders of the 10 and 15-ton locomotives are 7¼ by 9 ins., while those of the 25-ton design are 7¾ by 12 ins. These locomotives can be equipped to burn gasoline, naphtha, alcohol, kerosene, or distillates of 42 deg. Baumé or higher, and having a flash point of not over 120 deg. Fah.

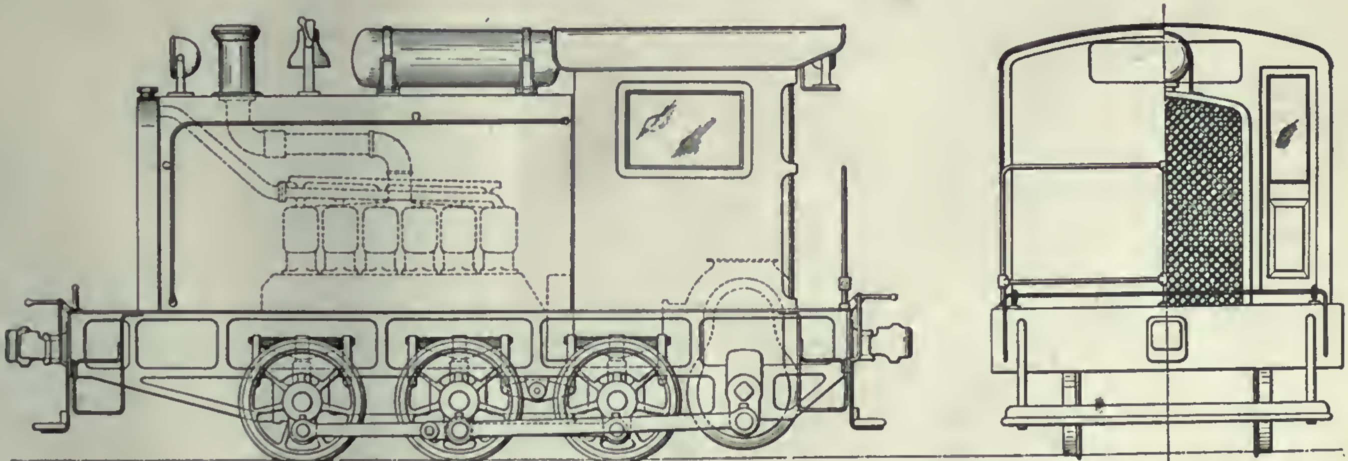
The main frames are of the cast steel bar type, and are generally similar to those used in steam locomotive practice. The frames are usually placed between the wheels, but in locomotives of exceptionally narrow gauge, it is necessary to place them outside in order to provide room for the motor and transmission. The axles are of high-grade forged steel, with large journals. The journal boxes are of special design, with removable cellars which are held in place by turned bolts. The side or connecting rods are of hammered steel with solid ends, and have bronze bushings hydraulically inserted.

The fuel tanks are of seamless drawn steel. When possible they are located over the hood as shown in the drawing and have a gravity feed to the carburetor.

The following are the general dimensions of the 25-ton type: Diameter and stroke of cylinders, 7¾ ins. by 12 ins. Diameter of driving wheels, 36 ins. Wheel base, 8 ft. Height over cab, 11 ft. Length over frames, 19 ft., 10 ins. Width over all, 9 ft. Gauge, 4 ft. 8½ ins. Fuel tank capacity, 50 gals. Horsepower, 135. Traction power at 4 miles per hour 9,400 lbs., at 6 miles per hour 6,100 lbs., at 12 miles per hour 2,700 lbs. Brakes, standard.



7¼ BY 9 INS. SIX-CYLINDER ENGINE, VALVE SIDE.



GENERAL ARRANGEMENT OF SIX-COUPLED, 15 AND 25 TON LOCOMOTIVE.

Heating of Car Wheels.

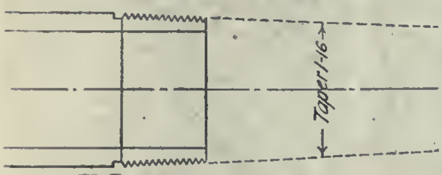
A complete investigation of the heating of chilled cast iron car wheels has recently been made, and while the failures of wheels of this type are comparatively rare, it has been noted that in railroads having long grades, quite a number of derailments have occurred at the bottom of these inclines. It has been determined that the cause is due to the failure of the wheels on account of heating due to the prolonged application of the brake shoes on the descending grade. Extremely high stresses are set up within the wheel which ultimately cause cracking and failure. Much ingenuity has been shown in perfecting a laboratory apparatus capable of producing conditions similar to those met with in actual service. The wheel is mounted in a vertical position and surrounded by electrical resistance coils insulated from but setting close against the rim of the wheel. Holes are drilled in the wheel at all points at which it is desired to obtain temperature measurements, and into these openings thermometers are inserted. The wheel can thus be heated to any desired temperature at the rim, and the corresponding temperature at other portions easily read. A large number of wheels have already been tested and others are being submitted to tests from time to time and authoritative data on the subject are expected to be ready for publication at an early date.

Screw Threads and Screw Thread Equipment

By J. F. Springer

Briggs Pipe Thread.

The Briggs pipe thread is the standard type of pipe thread in the United States. It is usually employed in a spiral form—that is the ridge of the thread lies on a conical surface. The tapers of the external and internal threads are, naturally, made the same. The great advantage of the tapered co-acting threads is that a very tight joint can be made, in so far



Briggs Pipe Thread
FIG. 7.

as tightness relates to the grip of thread on thread. Of course, even with the Briggs thread there may remain a slight space between the top of one thread and the bottom of the co-acting groove. There may, accordingly, exist in the case of a pipe thread and the coupling, a double line of spiral air space through which steam or oil may pass. To prevent this passage, it may often be necessary to use some kind of packing material, such as red lead. Aside from the taper, a Briggs thread proper is a sharp 60 deg. V-thread, with the top of the thread and the bottom of groove rounded. The rounding takes off at the top a certain proportion of the depth and the bottom of the groove is left in to the same amount.

The formula is:

$$(7)\quad d = 0.83301\ p$$

Dividing both sides of this equation by 0.83301, we get

$$(8)\quad p = 1.20047\ d$$

Suppose now that 8 turns per inch are called for, and it is required to determine the depth of the thread to be cut. The value of p is readily found by dividing 1 by 8. We thus get p = 0.12500 inch. Using formula (7), we now get $d = 0.83301 \times 0.12500 = 0.10413$ inch.

However, the problem might have been given us the other way round. Thus, we might have been given the depth and have been asked the number of turns per inch. That is, we might have been given *d* and have been required to determine *n*. Suppose, for example, that we are told that the depth is 0.05950 inch, and are required to determine the number of turns per inch. The proper formula is No. 8. We have

$$p = 1.20047 \times 0.05950 = 0.07143 \text{ inch.}$$

Dividing 1 by this value, we get the number of turns per inch,

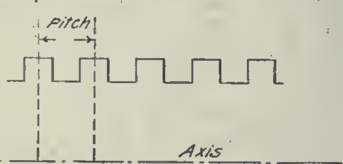
$$n = 1 \div 0.07143 = 14 \text{ (nearly).}$$

There are 14 turns per inch.

The taper allowed for Briggs threads is 1 in 16. That is, the diameter is diminished 1 inch in a length of thread (measured along the axis) of 16 inches. Or, what is the same thing, the diameter diminishes 1/16 inch for 1 inch of thread measured on the axis.

The Square Thread.

This is a thread which has been greatly in use for certain parts of machines. It is now coming to be displaced by the Acme thread. In the square thread the thickness of the thread and its depth are, theoretically, the same. The pitch is twice the depth, as may be seen from Fig. 8. In actual practice the square thread must fit into the square groove of the coacting part. If the width of groove and thread were made precisely the same, then there would be difficulty, if not impossibility, of running one thread over the other. Some allowance must be made. Either the thread is to be diminished in width or the groove is to have its width increased or both changes are to be made. Such variations will be matters for the



Square Thread
FIG. 8.

exercise of judgment at the time. One job may permit a trifle more play than another. I give the formulæ without allowing for a sliding fit of any kind.

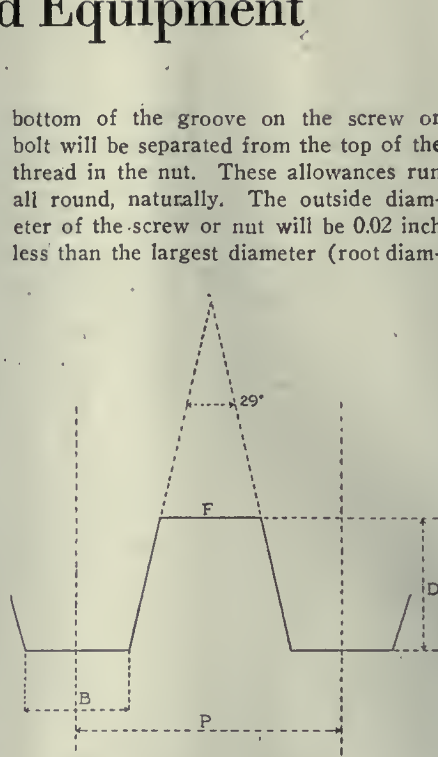
$$(9)\quad d = 0.50000\ p \text{ or } d = \tfrac{1}{2}\ p$$

$$(10)\quad p = 2.00000\ d \text{ or } p = 2\ d$$

The Acme Thread.

The Acme thread now coming into considerable use is a permissible substitute for the square thread in most, if not all, cases. Instead of squares for thread and groove, isosceles trapezoids are used. This will be seen from Fig. 8. That is, the sides of the thread and groove are inclined slightly from a perpendicular to the axis, the actual angle being 14½ deg. If the two sides of a thread are prolonged until they meet, the angle will be double this—that is, 29 deg. This thread may be cut with more ease than the square thread.

In order to provide clearance between the tops of threads and bottoms of grooves, the dimensions are suitably arranged. This amount of clearance is agreed upon as 0.01 inch. A screw or bolt in a nut will, accordingly, have its thread fall short of reaching the very bottom of the groove in the nut; and the bottom of the groove on the screw or bolt will be separated from the top of the thread in the nut. These allowances run all round, naturally. The outside diameter of the screw or nut will be 0.02 inch less than the largest diameter (root diam-



ACME THREAD (EXTERNAL)
FIG. 9.

eter) in the nut. So, also, the root diameter of the screw or bolt will be 0.02 inch less than the shortest diameter in the nut.

Formulæ for the Screw or Bolt.

$$(11)\quad d = \frac{p}{2} + 0.01 \text{ inch}$$

$$(12)\quad f = 0.3707\ p$$

$$(13)\quad b = 0.3707\ p - 0.0052 \text{ inch}$$

Here *f* stands for the width of the flat at the top of the thread; and *b* stands for the width of the flat at the base of the groove. The diameter of the tap used to cut the thread in the nut is to be 0.02 inch greater than the outside diameter of the screw or bolt. The Acme thread is sometimes called the Powell thread, its origin being due apparently to Messrs. Handy & Powell.

Lathe Tools for Threading.

Cutting threads on the engine lathe is one of the most usual methods employed. Usually, by this procedure, a tool with a single tooth is used. That is, for example, if a sharp 60 deg. V-thread is to be cut, the tool that is secured in the tool post will have a cutting edge formed of a single 60 deg. triangle. Similarly, with other threads. The tool cuts the groove, which results in the formation of the thread. There are a number of points of a very practical character, which must be covered, if a high-class thread is to be cut with efficiency.

The cutting edge is flat on top; it is given the exact form of the axial section of the groove wanted, and it is set horizontal and at the exact level of the axis of the rotating blank. The blue-print by which the workman is guided has its basis on the axial section. If a 60 deg. thread is wanted, this means 60 deg. in the axial section, and not 60 deg. somewhere else. So, then, in shaping, setting and operating the tool and lathe, this axial section is the thing that rules. The cutting edge is given the angle called for by the axial section. Consequently, when this cutting edge is put to work, it must be in an axial section of the rotating metal. This means that the flat top of the nose of the tool must be so set that, if this flat top be extended, the extension will pass through the axis of rotation. Now the easiest location to arrange is the location where the flat top is set precisely horizontal and so that the level of this flat top is exactly the same as the level of the axis. When this is done, the cutting edge will cut the work in an axial section. If the tool is set a trifle higher, the cutting edge will not be in the axial section, nor will it be in it if the tool is set lower. However, the horizontal setting at the level of the axis is not the only setting possible, but it is generally the most convenient. The tool could be set at the top of the work with the cutting edge in a vertical plane. And this would be quite suitable, if the vertical

Representative Lathe Tool for Threading
FIG. 10.

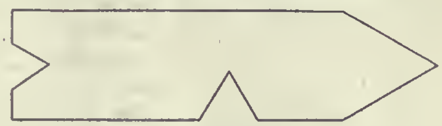
plane passes through the axis. Similarly, the tool could be set underneath the work or at the rear or anywhere round the whole circuit. And cutting could be done satisfactorily, provided the cutting edge is in the same plane with the axis. In general it will be most convenient to set the tool with the flat top as level as a spirit level can indicate and then make sure that it is at the exact height of the axis.

Often the top of the cutting part of the tool will be short, so that there may be difficulty in deciding whether it is exactly level. However, if the top of the body and the flat top of the cutting edge are made precicely parallel, then the workman need not level the top of the cutting edge, but can substitute the top of the main body. He may then level this long piece and know that he is doing the right thing. Of course, to take advantage of this substitution, there must be no lack of parallelism between top of cutting edge and top of main body. It is necessary not only to emphasize the need to make the tool thus in the first place. It is just as necessary to keep it so, as the tool wears and is re-ground. Properly, the grinding that goes on from time to time during the life of the tool will be done on the top surface of the nose. There should be no need to grind any other part of the tool after the tool is once finished at the beginning of its service. The two surfaces of the nose which correspond to the sides of the groove to be cut should be ground accurately at the start. This grinding should make the single edge where these surfaces intersect have precisely the angle with the plane of the cutting edge that has been determined on as best. Generally, this angle will be less than 90 deg. How much less depends upon the metal to be cut, etc. But note this point, the grinding of the side surfaces of the nose, the surfaces which run down from the sides of the cutting edge will settle this angle. So, then, these two surfaces are ground exactly as wanted at the beginning and are not afterwards disturbed. If the groove to be cut is not sharp-bottomed, then there may be a third surface to be cut. This will correspond with the flat at the bottom of the groove. On the tool, it will be a front surface on the nose and will lie between the side surfaces that are ground.

Perhaps the best thing to use for sizing and gaging is a flat piece of thin steel in which a groove has been cut and finished to the precise form (but not necessarily size) of the axial section of the groove wanted. If the groove wanted is, say, a sharp 60 deg. V groove, then a sharp 60 deg. angle should be notched in the flat piece of steel. The groove may be deeper than the depths required for the thread. In the present case, this will not matter. When sharp 60 deg. V threads are cut on a lathe, the side edges of the cutting edge which forms the groove may be longer than the sides of the groove wanted on the bolt. That makes no difference. The tool is fed into the rotating metal until the right depth is gotten, and then it is halted. In fact, one tool for sharp 60 deg. V threads may be used for threads of various depths. But one single tool will not do at all for U. S. Standard threads, unless such threads are cut, say, with a sharp bottom to the groove and the top of the thread is afterwards flattened as a second operation. The gage will properly be notched in the rough while the metal is in the annealed condition. It may then be hardened and tempered, and finally finished with the utmost exactness. In using it, it will be well to bear in mind that the gage itself has thickness. Error may come in if this is forgotten. But the trouble can be avoided by using either the top or bottom edge of the notch as the regulating line. If this is to be done, then that edge must be accurate itself. Or, accurate thread gages may be bought ready-made.

This notched gage is held parallel to the top of the body of the tool and is slid down the front of the nose, parallelism being maintained all the time. An exact match should exist at every moment. If the gage is held always parallel and an accurate match is always existent, then the tool is right, and the only grinding needed during its future life will be the grinding of just one surface—the top of the nose.

One difficulty will be encountered by attempting to prepare accurate gages in the ordinary shop. After a gage has been machined to approximate dimensions in the unhardened condition, it is then hardened. The final process is to grind the hardened steel to accurate size. However, a difficulty arises. If the grinding is done immediately after hardening, the finished gage is apt to suffer changes, due probably to a continued readjustment of the metal. It is better to forestall these changes, either by giving the hardened gage a long period of rest prior to grinding; or else taking it through an "aging" process, which may be carried out in a short period, and then doing the final grinding. However, this is a pretty high degree of accuracy. Where such accuracy in screw-threads is not in contemplation, the home-made gage which is ground immediately after



GUAGE FOR 60° THREAD
FIG. 11.

hardening will answer very well. Otherwise, it will generally be best to buy from a responsible maker a gage that has been allowed prior to grinding to age naturally or has been artificially put through an aging process.

The lathe operator may use his own taste and judgment about some things. The length, width and depth of the body may be varied a good deal, without affecting the work appreciably.

The length is the least important of all. The body should be long enough to enable the tool post holding device to get a firm and solid grip. The depth should be generous for two reasons. (1) It is the metal in the depth that stands up against the transverse feed of the tool into the work. The width resists the longitudinal feed, so it must be generous too. (2) The second reason for a generous depth is that the deeper the tool nose, the more grinding can be done on the top. That is, a deep tool is one capable of long life. It must be recollected that the tool projects forward from the tool holder and must resist the two feeds by its stiffness. The tool needs to be stiff, which is not exactly the same thing as strong. In addition to depth and width, it will be advantageous to pay attention to shortening the projection as much as possible, as such shortening means adding to the stiffness. Further, the width of the head of the tool should be kept as near to the width of the body as it is practicable, so as to preserve stiffness.

On the top of the tool body there should be a long grip if possible, not just the end of a screw or the like. The general idea is to make the tool practically one piece of metal with the tool post and holder, so that there will not be any yielding during the cutting operation.

Light, swift cuts are undoubtedly the best for accurate threading. The tool may be kept from heating by rigging a jet of water or oil. The jet should discharge onto the point where the tool is making the cut. That is the place where heat is generated, and consequently that is the region to keep cool. The final cut or cuts should be very light indeed so as to avoid the slightest tendency to jarring and chattering.

Before making the final cut, remove the tool and give it a careful grinding. Then with the tool sharp, run over the whole thread with an exceedingly light cut or two.

Work to be threaded exteriorly may often be secured in a chuck supported by the face plate and spindle. But such work should never be removed until finished, as it is practically impossible to put it back on the lathe in the exact position it was in before. This is especially the case as to the axis. The prolonged axis of the spindle becomes the axis of rotation of the work. When the work has been fairly started and a number of cuts made, an axis of the work itself has been created. This is in coincidence with the prolonged axis of the spindle. But if the work is properly mounted between a live center set in the spindle and a dead center set in the tail piece, the work may be repeatedly removed and replaced without detriment to the accuracy.

Bent Tools.

Sometimes, perhaps generally, the lathe operator will find it convenient not to use a straight tool, because of some inconvenience in using it when the thread gets close to the head of the lathe. The tool may be bent so as to make a horizontal angle when the tool is set in the tool holder ready for service.

A Further Point as to Setting the Tool.

The perpendiculars from the centers of the bottoms of groove notches to the axis make equal angles with the sides of these groove notches. Consequently, the cutting edge of the nose of a tool cutting into a groove must have the bisector of the angle of the cutting edge precisely at right angles to the axis. This is true for most threads—such as the sharp, 60 deg. V thread, the United States Standard thread, the Acme thread. A similar rule holds even for square threads.

Assuming that the sides of the nose have been accurately ground in such way that, at the beginning and all through subsequent grindings, the side lines of the cutting edge will always make equal angles with the center line. Assuming that the tool be properly made, a very simple gage will suffice, in ordinary cases, for determining the setting.

Recapitulation.

Aside from firmness, strength and rigidity, there are three principal points to cover when setting the tool. (1) The top of the head, or the top of the whole body, is to be exactly level. (2) The top of the cutting edge must be at exactly the same height as the axis of rotation of the work. (3) The center line on the top of the head must be perpendicular to the said axis.

As to making the tool, aside from forming it to promote rigidity and strength—there are four points to cover (1) The top of the head is to be made parallel to the top of the body. (2) A center line is to be laid off on top of the nose or head. A similar line is also to be laid off on the opposite surface, underneath the nose. (3) The sides of the nose are to be ground so that the two side edges on top of the nose will make equal angles there with the center line; and so that the two side edges on the opposite surface will there make equal angles with the center line. (4) The horizontal sections through the nose must all have the same form and size, from top to bottom of the nose.

As to making the tool, it should be deep and thick. Its material and temper should suit the metal of the work and the job in general.

As to cutting, no very heavy cuts should be made at any time, and the final one or two should be very light ones.

Aside from accuracy, the setting should be firm and solid. This is secured, in part, by long contacts against the holding surfaces in the holders. There should be only a short distance between the tool post and the work, to avoid too great a leverage.

Water Supply Well, Delaware & Hudson Company

The accompanying illustration is a photographic reproduction of something new in the way of obtaining water in the vicinity of railroad shops, and the supply is both economical and excellent in quality.

The Colonie shops of the Delaware & Hudson Co. at Watervliet, New York, are build upon what was once marshy ground that required several feet of filling in. This, however, had no effect upon the original water bearing strata. In order to utilize this as well as to serve as a drainage pool for the grounds, a well 50 feet in diameter and about 40 feet deep has been sunk near the southern limits of the grounds and where the ground was especially damp. The water seeping into this well is pumped to a tank at the shops and used for boiler and wash-out water for the locomotives. It is especially well adapted to this purpose as it is free from acid and scale-forming materials.

The Automatic Train Control Problem

We took occasion last month to present an abstract of the leading features of the report of the committee appointed by the United States Railroad Administration last year to report upon the subject of automatic train control. The real gist of their report consisted in presenting a list of no less than seventeen devices available for further test. This, together with an exact categorical statement of the requisites for the design and construction of automatic train-controlling devices constituted a report of real value in marked contrast to the alleged work of many committees that report progress, although no real progress has been made.

In relation to the same subject H. S. Balliet, signal engineer, electric division of the New York Central, presented a paper before the New York Railroad Club on March 19, in the course of which he reaffirmed the report that there are in use in this and other countries stop and automatic train control systems, but added that not one of them meets the specification contained in the presentation following:

"The transmission of 'information' for the control of the train and air brake, from the roadside, receiving and sustaining same, is the problem, and is difficult of solution. There are available, for test purposes, seventeen devices comprising five types of automatic train control. Actual road installations must be made to prove their usefulness.

"It is important that the matter of transportation be at all times accurate; otherwise traffic will be disarranged.

"It is not difficult to apply devices on the roadside to 'stop' the train. It is, however, very difficult to install automatic train control to meet the operating conditions. If you only stop your train, then you must sacrifice 'track.' Automatic train control with 'speed control' must maintain, in block signaled territory, existing operating requirements, and, if possible, increase track capacity and provide greater safety.

"Very little progress has been made in meeting the requirements of speed control. The most important conditions to be met are:

"1. To prevent a predetermined speed being exceeded regardless of track conditions.

"2. To permit a train to proceed at a predetermined low speed after having been stopped by an automatic brake application.

"3. To permit a train to pass a brake application point at a predetermined speed without receiving an automatic brake application.

"4. To permit a train to pass an approach indication point without an automatic brake application providing the engineman properly observes the approach indication.

"5. To permit a train to proceed without an automatic application of the brakes as long as the speed of the train is controlled in accordance with the signal indications.

"The installation of automatic stops and automatic train control devices should be made with complete track circuit control and a signal system controlled by the same track circuit. This in order to meet the need for more complete train protection. Experimentation with, or adaptation of, some form of train control device without the signal system is inconsistent with good operating requirements.

"The practical development of automatic train devices, and their use to supplement existing automatic block signals for the purpose of compelling obedience to signal indications, is highly desirable.

"The installation of automatic train control appears feasible—assuming that a type to meet satisfactorily the operating conditions will be fully developed—to protect trains moving with the established direction of traffic on main tracks. The necessity for automatic train control must be developed in each individual case.

"As automatic train control is most necessary for the protection of high-speed trains, the apparatus must be suitable, with reasonable maintenanace, to operate efficiently on such trains at the highest permissible speed and must not restrict the operation of the engine over any track which it may use. The brake application as made by the train control device must be such as to bring safely to a stop the trains of various classes without endangering the controlled train or trains on adjacent tracks more than would occur if the brakes were applied by the engineman.

"Automatic train control devices may be expected to prevent only such accidents as are due to the failure of employes to observe, understand, and obey signal indications. Failure to see or understand signals may be due to smoke, fog, snow, absence of the night signal indications, complexity in the scheme of indication, unfamiliarity of the engineman with the route over which the train is running, the diversion of his attention, or his physical incapacity, etc. Failure to obey signal indications that are seen and understood are rare and includue only those cases where enginemen in their anxiety to make time take chances, or where they use poor judgment in the interpretation of rules, which permit them to exercise some discretion. Statistics show that most of the collisions which have occurred on tracks protected by track circuit-controlled signals are due to the causes above enumerated.

"There appears to be a popular misconception as to the number of fatalities that might be prevented by automatic train control devices. Statistics show that train collisions have been the cause of less than six per cent of the fatalities to persons, other than trespassers, occurring on the railroads of the United States in the five and one-half years ending December 31, 1918.

"Automatic train control is popularly regarded as a panacea for railroad accidents. Persons who are not familiar with railroad operating requirements generally fail to understand fully the factors which must be taken into account in the practical use of train control devices. On this account a comprehensive statement of the question involved from the standpoints of construction, maintenance, and operation is desirable.

"Briefly stated, the automatic train control problem is to provide some appliance to furnish protection against accidents when employes disregard signal indications, or, so far as possible, when signals 'improperly' indicate proceed. The problem comprises two main elements, one of which consists in reproducing upon a moving train, either by mechanical or electrical means, a correct indication of the condition of the track ahead; the other requires proper means for controlling the train in obedience to the indication given. The first element necessitates the use of suitable mechanism along the roadside, while the second requires the use of suitable mechanism installed upon the train, both of which must properly correlate and function interdependently. Important factors entering into the problem are:

"(a) Reliability in operation; that is, it must respond with certainty to all the conditions under which it should act, and should remain inert at all times when conditions are such that a train may proceed with safety.

"(b) Inspection, maintenance, and test to insure efficiency: Proper inspection and maintenance of automatic train control devices will be more difficult than the inspection and maintenance of track circuit controlled signals, for the reason that part of the apparatus will be located on the roadside and another part upon the train.

"(c) Clearance: Relation between parts of the device and obstructions on the roadside or train: The location of automatic train control apparatus on train or roadside requires detailed study in an effort to secure satisfactory operation. Clearances are materially affected by tunnels, bridges, station platforms, track pans, grade and highway crossings, etc.

"There are two general classes of automatic train control devices:

"(1) Contact: Those that depend for their operation on the physical contact of an element carried on the train with an element at a fixed location on the roadside.

"(2) Non-contact: Those that depend for their operation on an electrical or magnetic impulse without physical contact between the roadside and train elements.

"A large part of the development has been in devices of the contact class. There are many troublesome clearance problems which enter into the solution of their application and use.

"In the non-contact class the clearance difficulties are very materially reduced and evidently this fact has been one of the leading causes for the development work that has been and is now being done with this class of devices.

"(d) Capacity: The effect upon the traffic handled over a given section of railroad: A properly operated automatic block signal system adds to the capacity of a railroad by increasing the freedom and flexibility and train movements over it. This condition should not be unduly interfered with by the use of an automatic train control device. It is apparent, however, that if such a device is to stop a train only in the occurence of those emergencies caused by the failure of employes to obey signal indications, the automatic brake application must be made a sufficient distance away from the actual point of danger to bring the train to a stop before reaching that point, under the most unfavorable conditions. This involves the necessity of providing maximum braking distance for all trains equal to that required for any train on the road. This cannot be done without decreasing the track capacity and on congested railroads is therefore a matter for serious consideration. To overcome these difficulties permissive features have been installed to enable the engineman to nullify the brake application and speed-control apparatus is being developed.

"(e) Interchangeability as between different devices on track used by railroads jointly: The joint use of a track by two or more railroads is frequent throughout the United States and essential in many cases to economical operation. This practice, as well as the joint use of terminal facilities, has been extended during the past two years, and will, without doubt, become more general. It is necessary, therefore, that automatic train control devices shall be so designed that the engine equipment of the various lines will properly function with the roadside apparatus on tracks used jointly.

"This requirement does not refer to detouring in cases of accidents, making it necessary for the trains of one company to move over the tracks of another. Such movements are handled by a qualified employe of the owning road in connection with the crew of the detouring road. The automatic train control apparatus should be so designed as to be operative in all cases on the engine of the detouring road, but the equipment detoured must conform with the clearance requirements on the road used.

"(f) Co-relation with track circuit controlled block signalling and air brake apparatus: The use of electricity controlled block signals has resulted in materially increasing the safety and efficiency of train operation, and it is essential that automatic train control apparatus shall be so designed that it may be superimposed upon the block signal system and not interfere with the performance of the signals.

"It is also essential that the engine apparatus of automatic train control devices shall be adapted to use with the air brake system existing and shall not interfere with its practical operation.

"The cost of an automatic train control system is an undetermined item which involves not only the original expense of installation but also the cost of maintenance and the effect of its operation upon the capacity of existing facilities. If a device materially reduces the capacity of a railroad, its installation where heavy traffic is handled may necessitate further expenditure for additional running tracks. A device to meet satisfactorily such conditions must therefore be one which will interfere as little as possible with the capacity of a railroad, and this requirement may necessitate the addition of speed control apparatus at an increased cost for its installation and maintenance."

Mr. Balliet also presented some interesting historical data from which it appears that the earliest record of an effort to undertake communication with, or from, moving trains is Pohl's patent, dated January 11, 1859, proposing a method of enabling moving railroad trains "to telegraph their own passings at certain stations."

Wallwark, on January 29, 1867, was granted a patent "for applying to the track an adjustable incline plane, and applying a plunger and lever to the locomotive and connecting the lever to the throttle valve and alarm whistle in such a manner that when the inclined plane on the track is adjusted in a certain position the plunger on the locomotive will, as the locomotive passes over the incline plane, be moved or actuated so as to cut off the steam and sound the whistle."

Until the air brake was developed, the use of automatic train control devices was considered inadvisable. The first form of straight air brake was invented by Westinghouse in 1869. The automatic air brake was invented in 1872. The use of automatic train control devices, in connection with the train brake system, was, therefore, not available for use until the latter development was made available.

Superheater Flues and Dampers.

A great deal of the economy obtained in the superheater depends upon the condition of the large flues and the proper operation of the damper. When the large flues are allowed to become stopped up with honeycomb and cinders, the result not only affects the superheater, but the steaming qualities of the boiler as well. The stopping up of the large flues makes it impossible for the heat from the flue gases to come in contact with the units and makes the superheater inactive. This condition also reduces the evaporating surface of the boiler and affects the steaming qualities and makes a superheater locomotive with all larg flues stopped up a poorer proposition than a saturated steam engine of the same size. Of course, it is not within the duty of the engineers to clean flues, but if the engine fails to steam due to the fact that they are stopped up he should report the conditions at the terminal and insist upon them being cleaned before engine is taken out again. Upon the operation of the damper the steaming qualities of the engine depends largely. When the damper is operating it should be open when the engine throttle is open and closed when the engine throttle is closed. If it fails to operate on the road it should be tied open until the end of the trip in order to prevent an engine failure and should be reported at the terminal to be repaired before engine goes out again.

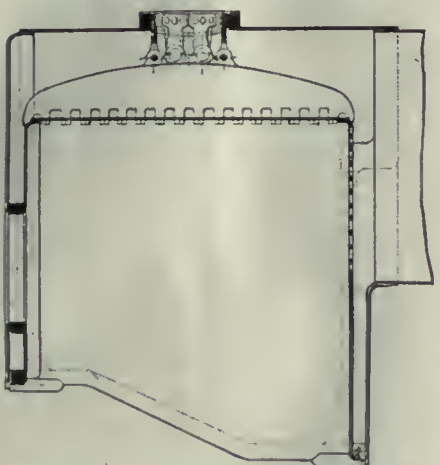
A New Type of Fuel.

Reports from Great Britain state that remarkable claims are being made on account of a new kind of manufactured fuel produced from coal, slack and dust, lignite, peat or other materials, with a binder of pitch. The blocks are formed of a number of layers, which have the same effect as the laminations in ordinary large lumps of coal. The new fuel can be made in blocks of any desired size, and by combining various types of material it is stated that a product of any required calorific value within reason can be produced. We understand that licenses to work the process have already been acquired by a number of collieries in Great Britain and that negotiations are in progress with many others. French collieries are also adopting the process, and Italian firms are displaying great interest in the matter. The Canadian Government and the government of Victoria are investigating the process with a view to employing it in the utilization of the extensive lignite deposits of Alberta, Saskatchewan, and the State of Victoria.

Steel Fireboxes in Europe

Interesting Experiments in Their Construction

It has been a subject of interest to American engineers for many years as to why European designers should continue the use of copper fireboxes in locomotives and have persistently reported against the use of steel. A number of years ago an elaborate test of steel fireboxes was made on the Paris, Lyons & Mediterranean Ry., and in spite of the great care with which it was conducted, the result was not favorable to the use of steel. Evidently something is the matter. Speaking generally nothing but steel is used for fireboxes in the United States and copper is used almost as exclusively in Europe. Here is a striking difference of practice that cannot be explained at first blush in any offhand manner. The preponderating use of copper has been explained on the basis of its greater conductivity. But tests made by the Pennsylvania R. R. on locomotives having steel fireboxes have shown that the rate of evaporation is as high in these boilers as in those having copper fireboxes and that the substitution of iron for brass in the tubes has not, in any way, reduced the rate of evaporation. As far as repairs are concerned, the two classes of fireboxes have always been about on a par, but since the introduction of autogenous welding, repairs on steel fireboxes have been more easily made than on those of copper. It is difficult, then, to understand the lack of success that has attended all European attempts to replace copper fireboxes with those of steel.



METHOD OF STAYING CROWNSHEET. ORLEANS RAILWAY.

In a recent issue of the *Revue Generale des Chemins de Fer*, M. Paul Conte, engineer-in-chief attached to the central office for the study of railway material in France, has an article discussing this problem and setting forth the results of some investigations that were made on the Orleans Ry. There are some conclusions drawn by M. Conte that are quite in harmony with American practice, while others do not agree with that practice and must be based on local conditions rather than on any general laws.

Take the Paris, Lyons & Mediterranean tests, for example. M. Conte says that these tests were cut short because the steel fireboxes suddenly cracked either in the body of the sheet or with the cracks radiating from a stay bolt hole and that these failures were attributed to a sudden cooling of the sheets, an hypothesis that seems to have been confirmed by experience with torpedo boat boilers of the locomotive type. These boilers had steel fireboxes and because of the necessity of raising the boiler well up in the frames of the boat, the firebox had to be made very shallow. These boilers were very sensitive to variations of temperature and while no trouble was experienced with the sheets, so many tubes leaked that the fires were put out in a few minutes, and such great care had to be taken in the handling of these boilers that they had to be kept closed for forty-eight hours after every test and allowed to cool very slowly, in order to avoid this leakage of the tubes.

The French engineers then came to the conclusion that, in order to keep steel fireboxes in good condition, it was necessary to avoid all sudden changes of temperature and that if the Americans had continued the use of steel fire-boxes, it was because they had taken special precautions along these lines of which European engineers were ignorant.

M. Conte states that on a trip to the United States, for the purpose of studying the matter of these precautions, he found two very definite rules in force.

1. Never wash or fill a boiler with anything but hot water.

2. Prevent, as far as possible, the scaling of the firebox sheets.

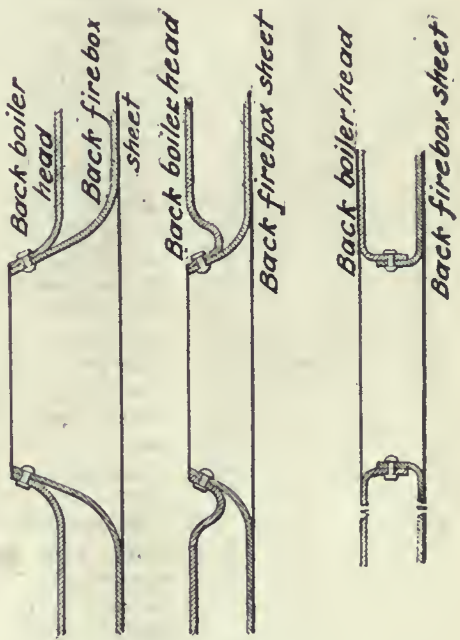
He then adds that the washing and filling of boilers with hot water is practiced in all of the large American roundhouses, while, in the smaller ones, the work is done with an injector on an engine under steam.

M. Conte is quite right in stating that this is recommended American practice, but it is probably an equally true statement that it is a practice more honored in the breach than in the observance, and that it is not followed in the great majority of American roundhouses.

He speaks of the great sensitiveness to heat of the torpedo boat boilers. True, but that sensitiveness probably holds for every type of boiler. In the November issue of this paper attention was called to the fact that a deflection of the staybolts could be detected within ten seconds of the throwing of a piece of lighted waste into a cold firebox, and also that so far as stresses arising from variation of expansion is concerned, it makes no difference as to the temperature of the water with which a cold boiler is filled.

But, however this may be, it is safe to say that the two rules set forth by M. Conte are far from representing universal practice in the United States because there is no universal uniformity.

Of course, we try to avoid scaling, but we don't do it and, when we don't, we suffer accordingly.



METHODS OF FIREDOOR CONSTRUCTION.

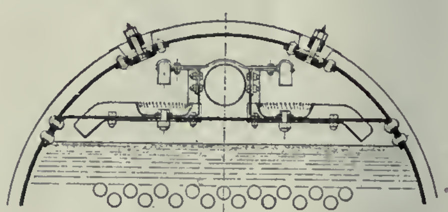
Before starting the test of steel fireboxes on the Orleans, a considerable extension was made in the practice of washing out and filling with hot water. In order to obtain the best results, twelve fireboxes were ordered from the United States and put in service in 1907-1908. They were delivered complete with staybolts in place and these were made of charcoal iron as in American practice. Then, in order to avoid as far as possible the scaling of the firebox sheets, it was decided to apply a special feedwater device in the steam space by which the feed was heated by the steam in the boiler, to a temperature approximating that of the saturated steam.

It is a very simple arrangement and is called the "feed pans," and consists of a simple plate, placed inside the shell above the water level, upon which the feed water falls. The water spreads over this plate in a thin layer before falling into the water below, and, being heated by its contact with the steam, precipitates its scale which sticks to the plate or is washed off at the edge and falls to the bottom of the shell. This prevents the crystallization of the scale on the sheets of the boiler and especially on those of the firebox. This, of course, requires the location of washout plugs in the shell, through which the whole plate can be thoroughly cleansed.

These feed plates have been put in all locomotives built for the Orleans since 1906, whether fitted with steel or copper fireboxes, and have never given any trouble, and the scaling of the boilers is reduced to a minimum. Furthermore, this raising of the temperature of the feed effects an equalization of the temperature at all points in the boiler and avoids the formation of cold zones at the bottom of the barrel or in the water legs. It was also found that those engines which were provided with the pans showed a perceptible increase of time between general boiler repairs, such as the renewal of fireboxes and tubesheets. So, because of the simplicity and inexpensiveness of this apparatus, as well as its efficiency, it has been generally adopted on all engines since 1906.

M. Conte then goes on to describe the failures that have occurred in the back sheet of steel fireboxes. There were two openings in the back head above the door formed in the same way by a heavy ring to which both sheets are riveted. Some trouble was experienced by the cracking of the sheets from the rivet hole out to the edge. Repairs were made by calking or by acetylene welding. But these cracks developed in such a way in some of the sheets that it was necessary to replace them with copper, so that the firebox became of composite construction. From which it is argued that when a solid forging is used for a door ring it is better to make the back sheet of copper, and since 1914 all steel fireboxes applied to the Orleans locomotives have been of this construction. But the idea of using an all-steel firebox has not been abandoned, though in doing so they have taken care to provide a flame shield to protect that part of the plate where the openings are located. In new boilers of this type a new design of fire door opening inwards has been applied which facilitates the design of flame shield above referred to.

The conclusion reached as a result of the Orleans test is that by taking the special precautions mentioned it would be an easy matter to substitute either steel or composite fireboxes for those of copper. As the steel fireboxes are much lighter and cheaper than those of copper, this is a matter of the first importance;



FEED PAN IN BOILER SHELL, ORLEANS RAILWAY.

but insistence is again made on the absolute necessity, before making a test or an application of these fireboxes to any large number of engines, that a start should be made to bring about the general use of hot water for both washing out and filling boilers, so that this should be done before putting these locomotives into service. As a locomotive may be required to pass several division terminals, it is important that the practice of washing and filling with hot water should be absolutely general lest there may be any risk of putting the firebox out of service, because of a single washing out with cold water under unfavorable conditions.

M. Conte attributes the cracking about the door ring to the method of construction and to the sudden changes of temperature, a matter which will be discussed in a future issue. He is probably right, as we have found door constructions such as are shown in the illustration better adapted to the avoidance of cracks than the solid ring. In like manner the cracks which he shows as occurring in the flanging of the back head are also probably due to temperature variations, a matter that will be discussed later.

From the dimensions of the fireboxes illustrated by M. Conte as in use on the Orleans Ry., there is no reason for any particular trouble to arise from the use of steel, as they have a length of only about 63 in. with a maximum depth of about the same, and a width of 44 in. But many in this country can remember the trouble with sheet cracking when the average American firebox was of about the same size. From what we have recently learned regarding firebox expansion, it seems that there is a probability that greater flexibility of construction would result in a decrease of trouble. For example, the method of staying the crownsheet is very rigid in spite of its apparent flexibility. The longitudinal crown bars are flexibly suspended from a heavy ring in the roof sheet, and are free to move back and forth with the expansion of the crown sheet. So far, well and good, but the crown sheet is most rigidly attached to the bar and has no chance for a local expansion at all because the bar must be of the same temperature as the water and steam. The result must be that during the whole period in which the boiler is in service the sheet must be buckling up and down between the points of support, while it cannot expand freely as it should, with the result, that we would expect to find the very cracks that do appear at the ends of the crownsheet and in the flanges of the back head. Certainly this particular construction is about as rigid as it can be for one that poses as flexible.

We have not yet solved all of our problems so far as the use of steel or any other metal in boiler construction is concerned, but much of the success that we have obtained is due to our use of a more flexible construction than previously prevailed, and it is probable that if our European brethren would follow suit and discard their rigid door and hole constructions and adopt those that were yielding; if they would use flexible staybolts in quantities and do away with the rigid method of crownsheet staying, it is probable that many of the troubles which they now experience with steel fireboxes would disappear.

Gravity and Brakes

There are few fundamental principles of natural laws, but the great seeming variation in their application gives a semblance of complexity that does not, in reality, exist. The law of falling bodies, for example, applies without a change in a single feature not only to falling bodies themselves, but to rising bodies, to the acceleration of a railway train under the tractive influence of the locomotive and the stopping of the same by the application of the brakes. These phenomena are usually expressed by formulæ which though simple in themselves are easily forgotten because they are not associated with any demonstration of principle but are set forth as mere facts.

In order to fix the whole law of the falling bodies and to be able to write the formula for the calculation of the acceleration and deceleration of any body but three things are necessary to remember:

1. That the rate of acceleration is uniform.

2. That at the end of one second of free movement a falling body has acquired a velocity of 32.16 feet per second.

3. That the result of any effort is proportioned to the force exerted.

Now let us make a graphical application of these fundamentals:

Draw the right angled triangle A B C. Then according to the rule for the calculation of the area of a triangle, the area of A B C equals the base B C multiplied by half the height A B. If A C represent the constant rate of acceleration of a falling body and A B the unit of time then the distance that it falls is equal to the final velocity B C multiplied by half the time occupied in falling A B. Then if A B represents one second B C will represent the velocity at the end of one second, and B C times one-half of A B will equal the distance fallen through in one second or 32.16 x .5 = 16.08 feet. The law holds for any other number of seconds and the details can be calculated according to the law that in similar triangles the homologous sides are directly proportioned to each other and that their areas are to each other as the squares oi their homologous sides.

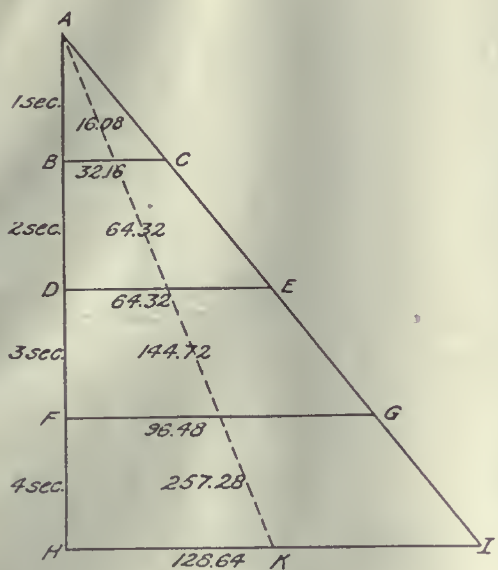


FIG. 1.

Thus the areas of the successive triangles A B C, A D E, A F G and A H I are to each other as the squares of their heights A B, A D, A F and A H or of the bases B C, D E, F G and H I. Or to put it concretely as 1 to 4 to 9 to 16. In other words the distance fallen in 4 seconds is 257.28 feet. Thus given the time of falling, the distance fallen or the final velocity, either of the other two elements can be readily calculated.

Now this presupposes the body to be acted upon by a force equal to its own weight as it is when freely rising or falling in the air.

But suppose the body is free to move and the force acts upon it horizontally. Then the rate of acceleration will be greater or less than that of gravity according as the force is greater or less. And here comes in the third of our statements.

The work done is equal to the force multiplied by the distance traveled. Now here if the force be one-half the weight the distance which the body will be moved in any given time will be one-half that through which it would be moved by gravity, and the line of acceleration would be the dotted line A K bisecting the several base lines and the velocities at the end of the consecutive seconds will be 16.08, 32.16, 48.24 and 64.32 ft. per second.

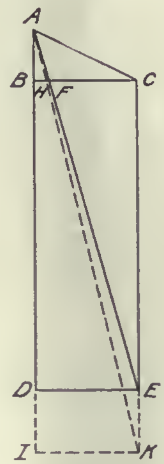


FIG. 2.

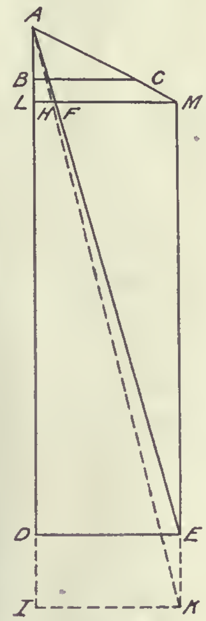


FIG. 3.

Now the same law holds for any other force applied to accelerate or decelerate a body free to move. For example, suppose a body such as a railway car to be moving at the rate of 32.16 ft. per second and brakes to be applied with a force equal to 70 per cent of the weight of the car. Suppose the co-efficient of friction of the brake shoes to be 20 per cent. Then the total brake resistance to the movement of the car causing its deceleration would be .70 × .20 = .14 or 14 per cent of the effect of gravity. To this may be added the internal resistance of the car, which may be taken at 8 lbs. per ton or 4 per cent, so that the total resistance tending to stop the car may be taken at 14.4 per cent.

To represent this graphically draw the triangle A B C (Fig. 2) in which B C = 32.16 ft. and A B one second of time. On B C lay off B F equal to 14.4 per cent of 32.16 or 4.63 ft. and draw A F extending it until it intersects C E at E which is drawn parallel to A B prolonged to D. Now D E will be equal to 32.16 ft., the line A D will represent the time required to bring the car to a stop and the area of the triangle A D E will represent the distance traversed in making the stop. But from the law of similar triangles A B : A D = B F : D E or B C.

But B C divided by B F equals 32.16 divided by 4.63 = 6.94. Hence A D is 6.94 times A B or 6.94 seconds, which would be the time required in which to stop the train.

As the area of the triangle A D E is equal to D E multiplied by one-half A D, it is equal to

$$32.16 \times 3.47 = 111.6$$

or the distance traveled by the car in making the stop would be 111.6 ft.

In like manner any other theoretical calculation can be made.

If the car is on a grade the weight of the car multiplied by the percentage of the incline of the grade must be added to or subtracted from the braking force according as the car is moving up or down the grade.

For example, suppose the above deceleration were to be made on a 2 per cent descending grade, the decelerating force would be reduced to 12.4 per cent of the weight of the car and the dotted line A K would represent the line of deceleration and B H would be equal to 32.16 × .124 = 4.09 ft. Making the same calculation as before A I would be 8.2 or it would take 8.2 seconds to stop the train and the distance run would be

$$32.16 \times 4.1 = 132.86 \text{ ft.}$$

which would be that required to make the stop.

Of course if the car were to be moving up the grade the 2 per cent should be added to the braking resistance, making a total of 16.4 per cent, in which case the stop would be made in 6.1 seconds and the distance required to make the stop would be

$$32.16 \times 3.05 = 98.11 \text{ ft.}$$

The same method may be used, of course, for speeds that do not agree with the falling speeds at the end of even seconds of time.

For example: Suppose the initial speed to be 45 ft. per second. Draw Fig. 3 as before, letting A B = 1 second and B C = 32.16 ft. Prolong A C to M, until L M = 45 and A L = 1.4. Then lay off L F and L H on L M equal to 45 × .144 and 45 × .124 or to 6.48 ft. and 5.58 ft. on the scale adopted respectively. Then proceed as before. Draw M E parallel to A D and prolong A F and A H until they intersect at M K at E and K, respectively. Then by pursuing the same method as before we find the time elements A D and A I to be approximately 9.8 and 11.2 seconds, respectively, thus making the distances run to make the stop

$$45 \times 4.9 = 220.5 \text{ ft.}$$

and $45 \times 5.6 = 252$ ft. respectively.

Such is the theoretical application of the fundamental principle, and the question arises as to why the diagram of deceleration of a train under the application of the brakes is never a straight line. It is simply because the deceleration force of the brake is not constant. First because the pressure in the brake cylinder is not constant and second because the co-efficient of friction of the brake shoe also varies, that is as the speed of the train varies and with the changes in its own temperature. Wind pressure and internal resistance of the car itself also tend to vary the deceleration line in the diagram, but through it all this simple fundamental principle of the law of falling bodies holds, and the whole rests on the calculation of the sides and areas of similar triangles leaving nothing to be really remembered except that at the end of one second of free falling a body will have acquired a velocity of 32.16 ft. per second. Such are some of the fundamental principles, the application of which should be carefully studied.

New Method of Autogenous Welding

According to the *Revue de la Soudure autogène* a new method of autogenous welding has been devised to take the place of the present one which consists in holding the torch inclined in the direction of the weld to be made and giving it a slight oscillating motion. The new method is called "welding from the rear" in which the welding bar, which the workman now holds in front of the torch and which, on melting, fills in the space between the sheets to be welded, is made to follow the torch instead of leading it relatively to the movement of the latter.

This process which was used by M. Roulleau, during the war for mild steel, and has been adopted in a number of French and Italian shops, has some marked advantages over the old system. It is claimed that the metal is sounder, the speed of welding greater, and finally that the saving in labor, gas and welding metal will amount to at least 25 per cent.

The fusion of the welding metal is not brought about by the point, but by the heat of the flame as a whole, the torch being inclined towards the rear, that is to say towards the welding bar.

The bar is inclined at a sharp angle along the line of the weld in the direction of the line of movement, that is to say at an angle opposite to that of the inclination of the flame. The angle of inclination of the welding bar with the line of the weld, that seems to give the best results, is about 45° for sheets of from 7/32 in. to 9/32 in. in thickness, an angle that should be decreased as the thickness of metal is decreased, becoming about 30° for a thickness of plate of 3/16 in.

This angle is also a function of the movement which should be given to the end of the bar along the line of the weld. This movement consists for the heavier sheets, starting at about ¼ in., by carrying the end of the bar as it is melted, from one side to the other of the line of the weld as shown in Fig. 1. For thickness of less than ¼ in. the movement should, at first, be ellipsoidal, then for sheets of from 3/32 in. to ⅛ in. in thickness, the side movement is gradually lessened until finally with sheets of 1/16 in. thickness the movement becomes purely forwards and backwards without any side motion whatever, as shown in Fig. 2. In both cases the end of the welding bar is kept constantly submerged in the bath of melted metal.

In order that the line of the weld may have a uniform appearance, it is recommended that the work be done at a uniform speed. But, if one end of the seam is attacked too vigorously with the torch, the melting breaks and a regular advance can only be obtained after a certain time and there will be some

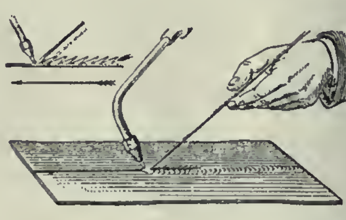


FIG. 1. Welding thick sheets

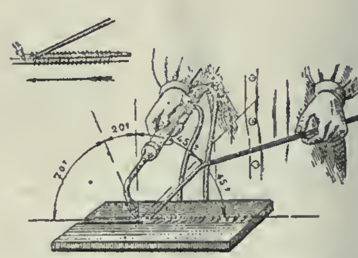


FIG. 2. Welding thin sheets

FIG. 1 & 2. Method of doing Autrgenous welding from the back

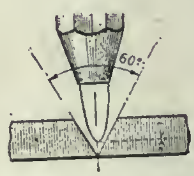


FIG. 3. Position of the torch, the point of the flame penetrating into the angle formed by the sheets

irregularities in the flow of the weld. If this is apt to occur it is well to preheat the sheets with the torch, for a few inches from the start of the weld so as to obtain a regular and normal speed of advance from the very beginning. The torch and the welding bar being held as indicated the point of the flame penetrating well into the angle of the chamfer of the sheets and the first bath of melted metal having been obtained by giving the flame a slight gyratory movement, and then plunging the end of the welding bar into this molten bath, when the regular advance movement of the torch can be given to it.

The bar which follows immediately after the flame will, on the other hand, have some to and fro movement, either at right angles to the line of the weld, or more or less elliptical or even directly in line with the weld, according to the thickness of the metal, but always with the care that the proper angle of inclination to the sheet is maintained.

The welding is thus done in a normal and continuous manner. The operator ought to obtain a sufficient supply of metal to fill the mold, with neither too little nor too much. On reaching the end of the weld, the position of the torch should be carefully changed so as to obtain a clean end, which can be done by a skillful manipulation of the torch and the melting bar in the usual manner.

The molten metal being always forced to the rear because of the inclination of the flame, the faces of the bevels or chamfers are always attached, the weld is what is called "well traversed" and lumps can hardly occur. However, it is well not to work too rapidly, so as to give the faces of the chamfers time to melt freely, and yet avoiding, by working too slowly, the formation of "projections" of molten metal at the back of the weld, because of the application of too much heat at the bottom of the V as shown in Fig. 3.

Better Train Service.

Improvements in train service for the public are said to be already experienced, since under the competitive basis many trains whose schedules have been reduced for one reason or another, chiefly the saving of coal, are returning to their old schedules, and the effect is being realized by travellers and by the Post Office department in the mail service. It is expected that in the early spring the service will have almost resumed its ante-war condition, but too much should not be anticipated as the shortage of equipment cannot be made up in a few months or, perhaps, years.

Locomotive Operation

During the winter months the various railroad clubs have shown a degree of activity that speaks well for the interest taken in the proceedings, usually of a kind connected with the actual working conditions in connection with railroads and the record of experiences, are of real value as leading generally in the direction of improving means and methods of general improvement. Frequently the style of the speakers is illumined by homely illustrations that add to the impression of the lessons that may be learned by the attentive listeners.

At the meeting of the Central Railway Club held recently, in discussing the subject of "Locomotive Operation," a paper on which had been submitted at a previous meeting, C. N. Page, road foreman of engines on the Lehigh Valley, at Buffalo, N. Y., speaking on the operation of the injector, stated that it was hard to regulate the operation of the locomotive or its various mechanical appliances to suit all conditions under which the locomotive is operated. It is to be understood that each time the reverse lever, injector or throttle lever is changed, it calls for a change of condition in the fire box. For example, you may see a tea kettle boiling on the stove, and if you empty a pint of water into it the boiling will stop; but if you pour the water into the kettle slowly it will continue to boil. If you cover the fire over under the kettle it will cease to boil, but if you feed the fire gradually it will contiue to boil until all the water is turned into steam.

The same principle applies to locomotive operation. The injector should be used continually while the engine is being worked and then regulated so as to just supply the demands of the boiler. The fire should be fed in small portions at frequent intervals so as to maintain as high and complete a rate of combustion as possible to maintain maximum steam pressure at all times. It should be demonstrated to the beginner that the uniform method of operating the locomotive or its appliances will bring about a more economical operation. The highest cost of our locomotive operation today is fuel. The economic value of any fuel depends on its heating power. Coal is divided into classifications according to the amount of carbon and gaseous matters it contains. Due to nature of the various coals applied on locomotives the question of educating the firemen as to the most economical method of burning these various coals is a serious one. You may have a coal that is very high in volatile matter. It has to be fired in a very light thin manner. On the return trip that same fireman would receive a tender load of coal of a different character and nature. If unfamiliar with it he would not be able to maintain steam pressure under the same conditions.

The subject of valve and cylinder blows, as to their location and cause, can best be understood in my opinion from charts. After an engineer is familiar with the reading of the chart showing the various valves and cylinder blows, he is able while in service to locate same. I am in favor of operating a locomotive with a wide open throttle when possible, and with a cut-off not less than one-quarter of the stroke. This is for the purpose of giving sufficient steam volume as near boiler pressure as possible against the piston. If this will increase the speed too high, the throttle valve should be regulated accordingly. In other words, I would like to have it understood that the locomotive at all times should be operated to maintain a maximum steam pressure instead of schedule speed. When the schedule speed of our trains cannot be maintained, where the maximum efficiency of our locomotives is being developed, the schedules should be adjusted. I believe to get maximum efficiency of our locomotives at all times, a thorough inspection system should be maintained at the completion of each trip, and while operating over the road rules and regulations regarding this be issued to suit the characteristics of the territory in which the locomotive is operating.

Where hydrostatic lubricators are used, and superheated steam, it is necessary to provide a drifting valve of sufficient size to allow sufficient steam volume to enter the cylinder while running at a high rate of speed shut off to break the vacuum that may be produced in the cylinder. On superheated engines the drifting valve should be open before the throttle is closed, and just before the engine comes to a dead stop, the drifting valve should be closed. I also believe that any valve oil ordinarily used to lubricate the saturated steam engine will be entirely satisfactory in lubricating cylinders and valves of superheated engines, provided a proper drifting valve is used and operated. Choke plugs should be examined at frequent intervals to see that the openings in them are of proper size and not stopped up, that and the oil pipes from lubricator to valve chamber contain no pockets.

J. A. Talty, P. S. Commission, Buffalo, N. Y., said that very elaborate tests had recently been made by the Federal inspectors regarding water glass and gauge cock indications. From what I learn we have all been wrong in our instructions to the locomotive engineer in regard to relying either upon the water glass indication or on the sound of the gauge cocks; that on our modern locomotives today it has been found that the circulation is so rapid in the boiler that the water is carried up along the back sheet of the fire box in the vicinity of where the gauge cocks are located, and will give an indication of a much higher water level than is really in the boiler; that in the near future all modern locomotives are to be equipped with a water column; an inch and a quarter pipe tapped into the wrapper sheet ahead of the knuckle of the boiler, and the lower end tapped into the water leg six or eight inches below the crown sheet. In that pipe, as I have said, is the water glass and the gauge cocks which will give an indication indirectly from the boiler to this pipe. All who have run a locomotive and who are still engaged in that capacity will no doubt agree that at times and quite frequently you can get a sound from the gauge cock that would indicate to you, if you opened and closed it quickly, that there was water in the vicinity of where that gauge cock is tapped into the boiler.

H. C. Woodbridge said that during the past two years he had been on some of the fastest trains on engines that were operated with the throttle wide open at high speeds, in one case at 90 miles an hour. However, that is not the best way to operate a locomotive under conditions often encountered. But when you are developing best practices, for Heaven's sake, don't condone the man that always runs with the lever down and regulates speed and power with the throttle. Certainly there is much to be gained by getting the lever back, and it can be gotten back and the engine run in short cut-off, if the wedges are up and the engine is in such condition otherwise that she don't shake you, as well as herself, to pieces. Intelligently conducted experiments will solve this problem for each case in hand. No set rule will apply without exception.

Some wonderful runs have been made during the past year with stoker fired locomotives. We no doubt were justified when the stoker was first introduced, in figuring that it was applied solely to increase the capacity of the locomotive, and that you could drop her down and widen on her, and tear up the earth, and the pointer would stay up where you want it; but as far as fuel economy was concerned, the stoker was absolutely and necessarily a fuel waster. This last conclusion is incorrect and I hope that as the number of stoker fired locomotives increases you will make the most of the possibilities for real fuel conservation. On four test runs last summer on the Baltimore & Ohio Lines West, between Chicago and New Castle, stoker fired locomotives handled tonnage trains on less coal per ton mile than I have ever seen recorded for hand fired locomotive performances anywhere else.

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General Inefficiency.

There is a general and well-founded complaint among all classes of employers as to the loss of efficiency of workmen since the commencement of the war and the era of high wages. Various reasons have been assigned for this, no one of which is probably the one and only cause, which may be a resultant of a combination of many of them. But the fact remains. A recent magazine asks if the American workman has lost the will to work, and the case of a man, having some chipping to do, is cited. This man, during the first hour of his morning's activity, struck two blows on his chisel, for which he was paid one dollar. The falling off in efficiency in railroad shops has been more than pronounced.

It may be that there would be a natural relaxation of effort when the intensity of the war-time drive was relieved. Just as a man naturally rests after an intense exertion, so that a part of the loss may be close to a psychological effect of the mass upon the individual. The scarcity of labor and the high wages paid undoubtedly has its effect upon the worker, who knows that if he loses one job he can readily get another, and whose money comes with an ease never known before.

Then comes the effect of environment and propaganda. Even at the time when the nation was in the throes of its distress and our Allies were frantically calling for help, there were frequent instances of labor representatives going among the men and telling them not to work so hard or so fast. A mere case of attempting to check the best man to the pace of the slowest. Then there is the printed appeal to do as little as possible, such as that which appeared in an I. W. W. newspaper, which gave this advice to its readers:

"Why strike with comparatively small groups of workers at a time when the majority of them are working? The result of such form of action is that in the place of strikes either scabs step in or the work is done by organized workers of other branches. Remain on the job, receive what is coming to you in wages, but work as slowly as possible. Such form of action will result in a general benefit to society. Workers, wake up and realize your power! *Work as slowly as possible!*"

When such an appeal affects a number of men in a shop, their example cannot fail to influence others, with the result that there is a general lowering of the efficiency of the whole. It takes a strong man and a strong will to work and to do one's duty in the presence of such an influence, especially as the high wages received are a constant reminder of the difference between the reward and the real value of the work done.

Again we preach the necessity for individual effort to counteract this tendency of inefficiency. There is an old theory much loved among workers to the effect that the less the individual does the more there will be left to do, and the more workers will be employed. In short, that the more the worker loves his fellow man the less he will do, that his fellow man may have the benefit of the untouched surplus. But somehow it never seems to work out well, for the cost of getting the little done by this altruistic workman deters the employer from having the surplus executed and there is nothing left for the supposed beneficiary.

But whether the present condition is due to recuperation from a strenuous endeavor to get high wages, to the scarcity of labor, to propaganda, or to any other cause, one thing is evident. We need a mental reconstruction, a change in the viewpoint of life and duty, and for this an appeal is again made to the individual to reconstruct himself and develop that will to work that makes for success and comfort for the person, the community and the nation. The idler has never been considered an asset, and it is the country with the empty poorhouse, the country where every citizen is a self-supporting worker that is the prosperous one. And there is no essential difference between the derelict who idles away his life on a poor farm, doing only that which he is driven to do, and the workman who strikes two blows with his hammer in one hour. They are both leeches who are sucking the blood of the toil of better men, and society would be well rid of them both.

The Organized Employees.

General satisfaction is expressed at the action of the organized employees of the railroads in announcing their intention in no longer resisting the new railroad legislation, but to co-operate with the government in the establishment of a permanent machinery of wage adjustment. The demands of the employees have been held in abeyance for some time, but the President has ordered both the railroad executives and the employees to proceed at once with direct negotiations before a bipartisan board to bring about a settlement of the pending wage controversy. The prospect that the organized employees might refuse to submit their claims to the labor boards had aroused considerable concern, consequently the announcement has been received with much satisfaction.

In the light of past experience it is assured that the advisory committees that hampered the action of arbitration boards will no longer be called into operation. Unless fully armed with authority, arbitration boards are worse than useless, because decisions are delayed beyond endurance and ill feeling engendered. The President has acted wisely in calling attention to the failure of the Government to reduce the cost of the common necessities of life, and that the time for determining whether or not the level of the cost of living was such as to be the basis of a permanent readjustment of wages, and while the matter had been delayed until the railroads had been returned to their owners, he would continue to use the influence of the Executive to see that justice was done. This does not mean that there will be arbitrary authority exercised by the government in reaching decisions, but rather that when the decisions are arrived at they may be relied upon as being the best that an unhampered, enlightened body of well qualified experts can arrive at.

The action of the arbitration boards will be watched with particular interest, and it is not too much to say that it is the best opportunity that has ever come for the exercise of common sense and mutual good will looking to the welfare of all concerned. Whatever decisions may be arrived at cannot be destructive of the interests of the railroads which are guaranteed a system of rates that will produce a reasonable income, and all that is left is a reasonable estimate of not how cheaply a railroad can continue to exist, but how far it is well to keep the lamp burning on the hard pathway in which he has to tread.

The Metric System.

The Metric System, like Banquo's ghost, will not down, and like Macbeth, we would venture to exclaim, "Come in any shape but that!" The basic principle being a decimal fraction, and generally divisible by the numerals 5 and 10, is so far surpassed by the system now in vogue in America and other leading manufacturing countries that it is hardly worth discussing the subject. Not only so, but after a century of frantic effort on the part of its champions, it stands exactly where it always stood—repudiated by those who are best capable of judging as being contrary to any improvements, and not meeting with general favor anywhere. To show any good reason for so important a change, so colossal in its cost, and so far removed from any advantage, has failed utterly.

The marvel is that the idea is so persistent. Like the feeble attempt to reform spelling, to which we have alluded before, it has far less reason. Spelling has been reformed since the days of Chaucer by the slow process of utility, and by the example of the master minds in literature, and, doubtless the reform will go on in its slow but sure way. Measurement is absolute, and the survival of the fittest has come to the most enlightened people only to be disturbed by dictatorial spirits that were a menace to civilization, the principal of which ended his days in St. Helena.

The present agitation in America comes from an infinitely smaller source. This source may be said to be peculiarly American. An active, shrewd man makes a fortune manufacturing and selling some commodity. In his old age, when he should be under trustees, he is set upon, as usual, by harpies who see an opportunity of exploiting a portion of the unguarded fortune. And the World Traffic Club of San Francisco sounds good for a name. Like Wordsworth's cuckoo, it is "an invisible thing, a hope, a mystery." The country is flooded with circulars, and the ready postal card is enclosed addressed to the President of the United States. A considerable portion of the cards are passed on to clutter up the post office, and the cards are passed to some tabulating clerk, and a member of Congress who might be better employed prepares a bill, and it does not require a great prophetic vision to see its finish.

While the subject, as we have already ventured to state, is unworthy of serious attention, it is gratifying to observe that nearly all of the leading scientific and engineering societies are joining in a protest against the proposition to enforce such a change. It has been already shown, particularly during the war period, that the American constructing engineers can fill any order in any kind of measurement with a degree of promptitude that surpasses that of any other country, and, it is only necessary to bear in mind that in answers to a questionnaire sent out to 1,445 of the leading exporters, 82.2 per cent reported that they have no need whatever for the metric system; 11.2 per cent are using it only slightly, while about 3 per cent use it to any extent, the remainder making no reply. The investigation was made by the American Institute of Weights and Measures, and first published by the American Society of Mechanical Engineers.

The Need of a Yard Foreman.

One of the best suggestions of the last few days in connection with operation of locomotives at terminals is that a yard foreman should be provided reporting to the roundhouse foreman, and whose duties would be to look after and personally supervise engines while they are at the roundhouse. Such a man would be in position of supervising not only the inspection of the engines and verify the necessity of running repairs made, as reported by engine crews, but would be of material assistance in getting repairs made. He would also be in position to accelerate the movement of engines over ash pits past the coal docks and make a lot of short cuts in the delays which keep engines at the terminals so long. A further improvement would be made if the traveling engineer and traveling fireman would spend a day each month with this yard foreman, comparing notes as to engineers' reports, conditions on engines and their operation over the road.

One road has obtained material benefit from having its traveling fireman and traveling engineer come in contact with the roundhouse foreman for several days a month, but because the roundhouse foreman is so busy a man it would seem the appointment of an engine yard foreman could better coördinate the terminal work with the operation of engines and by having time to do it would be a good investment for any railroad. It would certainly help the engineers and firemen and should materially improve condition of engines having an important effect on engine failures because it would make it possible to supervise inspection. It seems worth while to suggest that the Traveling Engineers' Association would find this a worthy subject for study and perhaps action.

Government Report on Locomotives.

W. T. Tyler, Director Division of Operation United States Railroad Administration, in his closing report to Director General Hines, claims that the locomotives of the country are in better condition as a whole than they have ever been before during a period of very heavy business, and while they number 65,100 an adequate program for new power should be adopted at an early date in order to take care of the commerce which there are abundant reasons for believing must be handled by the railroads in the months and years which lie just ahead.

There have been completed in the first nine months of 1919, 442 locomotives which were ordered prior to Federal control, 989 locomotives built to standardized design prepared by the United States Railroad Administration, and 103 locomotives constructed in railroad shops, making a total of 1,534 new locomotives placed in service during the first nine months of the current year.

Inadequate facilities for making repairs to locomotives and cars which were emphasized by railroads receiving heavier power during the war without proportionate increase in facilities made maintenance of equipment a delicate operation. From the beginning the Mechanical Department of the Division of Operation has diligently endeavored to maintain the equipment without any idea that economies should or could be realized by reducing maintenance which the equipment ought to receive, but with the thought that the fullest possible measure of maintenance should be given.

Experience with these standardized locomotives and cars has shown them to be of exceptionally good design and construction. The locomotives, wherever tested against similar locomotives built to individual designs, have shown superiority in the matter of efficiency and economy in operation, and while it is yet too early to give definite figures with respect to maintenance, it is being demonstrated that the standardized fittings and design of parts will reduce maintenance costs.

High Time to Get Fair Play.

The Cincinnati *Times-Star,* commenting on the railroad problem, claims that the pressing necessity is to straighten out the so-called railroad tangle as soon as possible, in a way to permit the transportation companies again to get on their feet and meet the needs of public service. Not only has new construction been at a comparative standstill, but equipment has sadly deteriorated and the service rendered has been a source of constant complaint and criticism.

And this condition will continue to grow worse until a wise and liberal policy toward the transportation companies is adopted and becomes effective, giving the roads a chance to get their share of general prosperity and thus encouraging them to resume new construction and put their equipment in shape to handle the rapidly increasing volume of traffic which is now on hand.

An Early Tender Design

By J. Snowden Bell

The water tanks first used on tenders were, as shown in various illustrations of early locomotive practice, wooden casks, which were either laid crosswise on a small car, as in the case of the locomotive of the British Wylam Railway (1825), or stood on end, as in that of the "West Point," on the South Carolina R. R. (1831), and while this water receptacle was soon superseded by the present standard U-shaped tank, others, of similar type, *i. e.,* wooden vats, of much larger diameter, set at the rear of a tender, with space for wood fuel in front, were in service on the Camden & Amboy R. R. for a number of years.

Another instance of a tank of this type appears in the tender illustrated in Figs. 1, 2 and 3, which is described and shown in *Organ fur die Fortschritte des Eisenbahnwesens,* Vol. 1, Plate V, 1846, as having been built for the Main-Neckar Railway, by Taylour & Co., Vulcan Works, near Warrington, England. The construction of the tender will be readily understood from the accompanying side, plan and end views, supplemented by the following notes from the description given in the German publication.

Fig. 1.

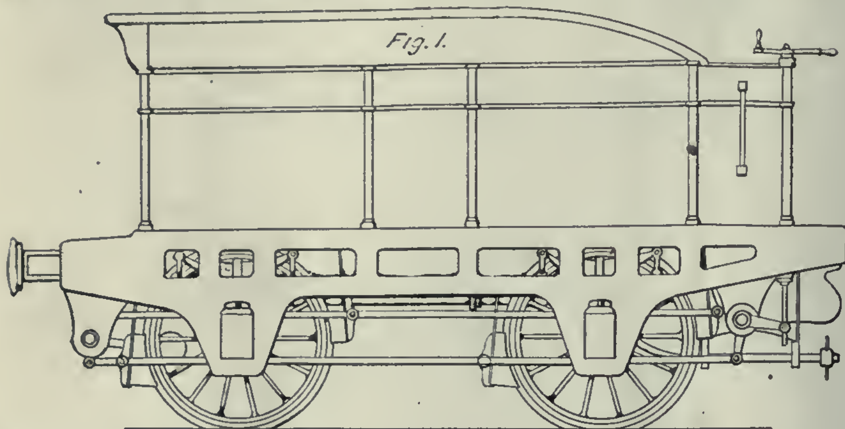
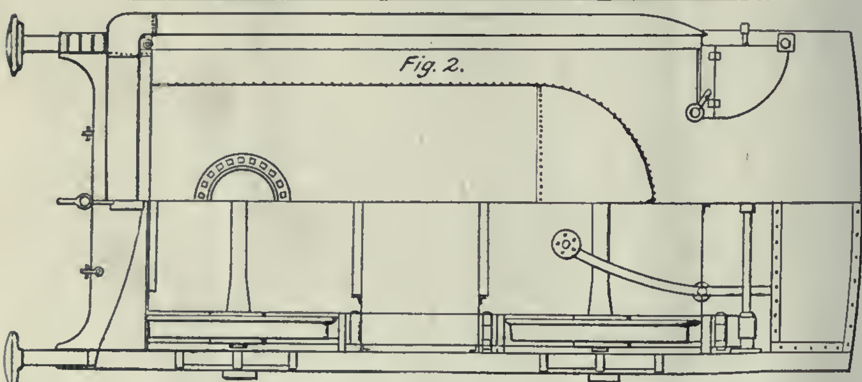


Fig. 2.



"The water tank M is cylindrical, of ¼ in. sheet metal, 4 ft. 5 in. diameter and 10 in. long; strengthened at its rear plane end, *h,* by a ring of angle iron internally, and supported by the ribs, *f* and *g.* The entire rear cylindrical part is composed of four plates running longitudinally, so that in cross section, Fig. 3, four riveted joints are seen, above, below, and at both sides. The front semi-spherical end is formed of five parts, as shown in Figs. 2 and 3. The inlet opening, L, is 15 in. in diameter, and around it is bolted a cast iron neck or connection, 1 in. high, to prevent overflow of the water in rapid motion. The copper water pipes, *i, i,* which lead to the engine, are bolted by flanges to the front lowest part of the tank, thence bent over the front axle, so as to be 3 ft. 6 in. apart, and running parallel to each other, are held in two connected hangers."

Fig. 3.

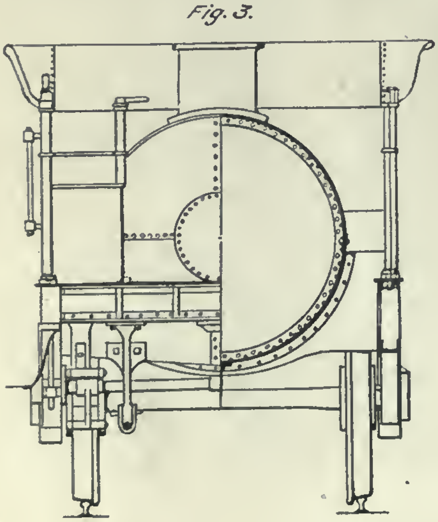
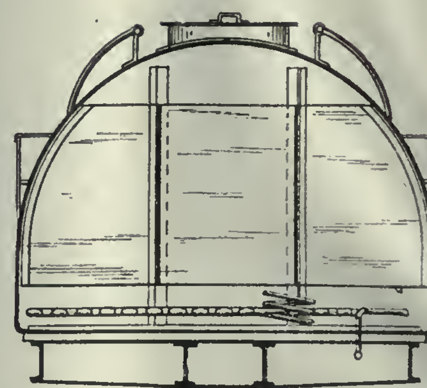


Fig. 5.

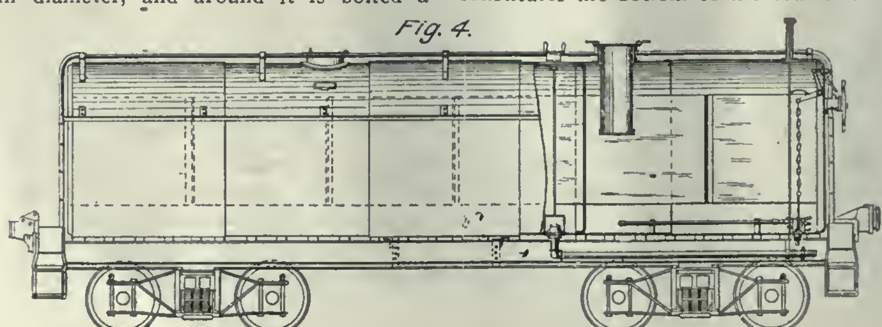


The supposed advantage of this form of tank is rather fancifully stated in the description to be that "the body of water is more compact than in ordinary tenders, and fewer walls are offered for it to strike against; it is, to a certain extent, made in the shape which is assumed by such a mass of water accelerated in the direction of train draft."

If this is of any substantial advantage in practice, it is equally attained in the tender tank of H. J. Small (U. S. Patent No. 745,372, December 1, 1903), shown in Figs. 4 and 5, which has been, for a number of years, and is now used with oil burning locomotives on the Southern Pacific System, there being now about 55 in service, some of them having a capacity of 10,000 gallons of water and 4,000 gallons of oil. The Small tender tank has the further advantage of increased water capacity and lower centre of gravity.

The cylindrical tank does not appear to have been applied, since the Taylour & Co. design of 1846, until its revival in the Vanderbilt tender (expired Patent of 1901), as modified by forming a depression in its top at its forward end, which constitutes the bottom of the coal bin.

Fig. 4.



Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page* 51, *Feb.,* 1920.)

1098. Q.—How is a leaky brake valve rotary usually repaired?

A.—By having the valve and seat trued up in a steady running lathe, and thereafter scraping the valve and seat to a perfect bearing.

1099. Q.—Should grinding material ever be used for this purpose?

A.—It is doubtful. A scraper must be used and the valve worked to a bearing surface "dry" if a perfect surface is to be obtained.

1100. Q.—What is meant by "grinding in" a rotary valve?

A.—It is merely an expression, a rotary valve cannot be ground to a perfect bearing.

1101. Q.—Why not?

A.—The outside surface will wear faster than the center when revolving and all the bearing contact would soon be at the center.

1102. Q.—How is a valve held in position while rubbing it to obtain the bearing surface?

A.—By having a wooden pin for the center of the valve or a brass band to encircle the valve.

1103. Q.—How far should such a band extend above the valve seat?

A.—About ¼ in.

1104. Q.—What else should be observed in connection with the rotary key?

A.—That it does not bind in the valve when in position and is not too free.

1105. Q.—Why not too free?

A.—It will result in what is termed too much lost motion in brake valve handle.

1106. Q.—What outside of a perfect bearing surface is to be noted in connection with the valve seat?

A.—That the preliminary exhaust port bushing is of the correct inside opening, and that the warning port is open and of the proper size.

1107. Q.—As to the H6 or type L New York brake valve, what is the object of the restricted port in the gage pipe tee?

A.—To restrict the flow of air to the equalizing reservoir.

1108. Q.—At what time is this desirable?

A.—During a two-application stop with a passenger train.

1109. Q.—Why?

A.—To prevent a high overcharge of the equalizing reservoir.

1110. Q.—What is the disadvantage of an overcharged equalizing reservoir?

A.—The equalizing reservoir pressure must be reduced below that in the brake pipe before a response of the equalizing piston can be obtained, and this is undesirable when an application must follow a release of a previous application of the brake.

1111. Q.—What has been done with recent types of brake valves to prevent an overcharge of the equalizing reservoir during a two application stop?

A.—They have been fitted with a collapsible type of equalizing piston.

1112. Q.—How does this piston prevent the overcharge?

A.—By collapsing and equalizing the pressure between the equalizing reservoir and brake pipe whenever there is two or more pounds difference.

1113. Q.—How are the two types distinguished?

A.—The collapsible type is in two sections, a spring being between the piston and stem portions.

1114. Q.—How may the lower cases be distinguished?

A.—The collapsible body has a series of grooves cut in the lower end of the piston bushing, just below where the ring normally rests.

1115. Q.—What is the effect of leakage in the equalizing reservoir or its connections?

A.—It depends upon the condition of the equalizing piston packing ring.

1116. If the ring is in good condition and the equalizing piston is a correct fit in its bushing?

A.—If in sufficient volume, the leakage will cause the equalizing piston to lift and discharge brake pipe pressure when the brake valve handle is placed on lap position.

1117. Q.—Has the leakage the same effect on the lone engine as when coupled to a train of cars?

A.—Not always, the leakage may not noticeably affect the lone engine, but will discharge brake pipe pressure with the handle on lap position when coupled to a train.

1118. Q.—Why is this?

A.—Because of the greater brake pipe volume of the train.

1119. Q.—How does the difference in volume affect the equalizing piston at such times?

A.—There may be both brake pipe and equalizing reservoir leakage on the lone engine, to which may be added a certain amount of leakage past the equalizing piston packing ring, so that leakage of the brake pipe exhaust port, if any whatever does exist, may not be noticed on the lone engine. After a greater brake pipe volume is added, brake pipe pressure may not leak away at the same rate that equalizing reservoir pressure is escaping and the larger volume will lift the equalizing piston and discharge brake pipe pressure as soon as the brake valve handle is placed on lap position.

1120. Q.—What then causes an equalizing piston to lift when the brake valve handle is on lap position?

A.—A decrease in equalizing reservoir pressure or an increase in brake pipe pressure.

1121. Q.—How can the difference be distinguished?

A.—By noticing the equalizing reservoir gauge hand.

1122. Q.—What is indicated of the piston lifts, with the handle on lap and the hand remains stationary?

A.—That there is a leak from the main reservoir or some other source into the brake pipe.

1123. Q.—Where could this leakage be from on a locomotive?

A.—Through a brake valve body gasket, through a leaky rotary valve, through a leaky double heading cock that is located in the reservoir pipe, through an open cock or a defective check valve seat of the dead engine fixture, through a defective distributing valve gasket, or back from some defective water scoop reservoir check valve, when it is supplied from the brake pipe.

1124. Q.—What defects of the brake valve contribute to undesired quick action?

A.—An enlarged preliminary exhaust port; brake pipe exhaust port enlarged; dirty or gummed up equalizing piston; too tight fitting equalizing piston or ring; conical end of piston stem filed off; exhaust fitting removed; a leak in the equalizing reservoir volume; wrong size of equalizing reservoir; reduced equalizing reservoir volume; restriction in pipe leading to the equalizing reservoir.

1125. Q.—Are there any other disorders found on the engine that will contribute?

A.—Yes, brake pipe leakage. A "sluggish" brake pipe feed valve. An overheated air compressor, and certain defects of the distributing valve, if it is equipped with the quick action cylinder cap, also too high a temperature of the compressed air in the brake pipe.

1126. Q.—How does an overheated compressor contribute?

A.—By scattering burning oil throughout the brake system of the locomotive.

1127. Q.—How does a high temperature of the compressed air in the brake pipe contribute?

A.—When a brake pipe reduction is

started, the expansion of the compressed air instantly reduces its temperature and with the reduction in temperature it contracts, so that the reduction due to temperature, added to that made with the brake valve, combines to make a reduction at an emergency rate.

1128. Q.—What is the effect of excessive brake pipe leakage?

A.—It wastes air, takes away from the engineman the ability to control the amount of brake applications, contributes to brakes sticking, causes overheating of air compressors and even prevents the maintenance of standard brake pipe pressure.

1129. Q.—What defects of a distributing valve with the quick action cylinder cap contribute to undesired quick action?

A.—A dirty or sticking equalizing valve, a weak or broken graduating spring, and a restricted service port, but far more likely, the use of oil as a lubricant for the equalizing slide valve.

1130. Q.—How does the use of oil or grease affect the operation?

A.—It "packs" the edges of the slide valve to the exclusion of leakage across the seat and makes it more difficult to move than if the valve seat was dry or lubricated with dry graphite.

(To be continued)

Train Handling.

(Continued from page 51, *Feb.,* 1920.)

1143. Q.—Where is service reservoir pressure permitted to branch off between the charging valve and the reservoir connection?

A.—To the application slide valve chamber in the application portion.

1144. Q.—Emergency reservoir pressure being in the emergency portion and equal on both sides of the large end of the emergency piston, what keeps the emergency piston in its lower, or release, position?

A.—The outside of the small end is open to the atmosphere through the release slide valve exhaust port.

1145. Q.—The equalizing piston also being a double ended piston, what is the object in having the outside end of the lower piston open to the atmosphere through the release slide valve exhaust port when the equalizing piston is in its release position?

A.—So that when a brake pipe reduction is made, the release piston must move toward its applied position before the equalizing piston and slide valve are moved.

1146. Q.—Why is this movement desirable?

A.—In all air brake apparatus certain chambers are open to the atmosphere when the brake is released and these chambers must be closed off from the atmosphere before any compressed air is admitted to them.

1147. Q.—With the brake released, is there any air pressure in the application chamber or the application cylinder?

A.—None other than atmospheric.

1148. Q.—In what way is it open to the atmosphere?

A.—Through the exhaust port of the release slide valve.

1149. Q.—What is necessary to apply the brake on a car having a control valve?

A.—After the reservoirs are fully charged, a brake pipe reduction must be made at a faster rate than at which it can flow back from the pressure chamber through the feed groove in the release piston bushing.

1150. Q.—When the required rate of reduction is made, explain the first movement of the control valve pistons.

A.—The pressure in the pressure chamber remaining higher as the result of the brake pipe reduction, the release piston and its attached slide valve and graduating valve will move until it is stopped by the release graduating spring and stem.

1151. Q.—What does the release slide valve do at this time?

A.—Closes communication from the application chamber to the atmosphere, closes the communication from the chamber at the lower end of the equalizing piston to the atmosphere and allows pressure chamber air to equalize with this chamber.

1152. Q.—What does this balancing of the pressure surrounding the small end of the equalizing piston result in?

A.—A movement of the equalizing piston and slide valves as a result of the difference in pressure between the brake pipe and pressure chamber.

1153. Q.—The first movement is termed preliminary service position, and when the equalizing piston moves, the control valve is in secondary service position; can you explain what transpires in this position?

A.—The equalizing piston and graduating valve have moved far enough for the equalizing piston to engage the slide valve and in this position a momentary connection is made from the emergency reservoir into the equalizing slide valve chamber.

1154. Q.—When the equalizing piston has moved the equalizing slide valve and come in contact with the equalizing piston graduating spring stem, the control valve is in service position, what is then transpiring?

A.—The movement of the release piston, having closed the feed groove and the ports leading to the equalizing check valve, the pressure chamber is entirely separated from the brake pipe, the slide valve has closed the application chamber exhaust port as explained and the graduating valve of the equalizing slide valve has opened the service port and air pressure is flowing into the application chamber from the pressure chamber through the equalizing slide valve.

1155. Q.—Are there any chambers of the control valve open to the atmosphere at this time?

A.—Yes, the reduction limiting chamber.

1156. Q.—When pressure chamber air enters the application chamber it is also free to flow to the application cylinder to become effective on the application piston, is the application piston promptly moved to application position?

A.—No, not until 4 or 5 lbs. pressure accumulates in the application chamber.

1157. Q.—Why not?

A.—On account of the tension of the application piston spring.

1158. Q.—What is the object of this spring?

A.—To prevent slight variations in brake pipe pressure from applying the brake on a car having the P. C. equipment.

1159. Q.—What causes variations in brake pipe pressure?

A.—Leakage and defective locomotive brake pipe feed valves.

1160. Q.—How is it then prevented from applying the brake?

A.—By adding this spring which prevents an application of the brake until such time as a definite 5 or 9 lb. reduction in brake pipe pressure is made.

1161. Q.—Explain the object of this position of the control valve?

A.—It is to hold the brakes applied with a fixed degree of force as determined by the amount of brake pipe reduction made.

1162. Q.—Explain the operation of the application portion when pressure chamber air enters the application chamber and application cylinder?

A.—After sufficient pressure to overcome the tension of the application piston spring has accumulated, the application piston and the attached slide valves are moved to application position.

1163. Q.—What ports are opened and closed at this time?

A.—The exhaust valve first closes the service brake cylinder exhaust port, after which the application slide valve opens a port leading from the service reservoir to the service brake cylinder.

1164. Q.—How long does the application piston remain in this position?

A.—Until the flow from the pressure chamber into the application cylinder ceases.

1165. Q.—What then occurs?

A.—The application piston spring returns the application piston to lap position.

1166. Q.—With what result?

A.—That the brake cylinder exhaust port remains closed and the flow of air from the service reservoir to the service brake cylinder is cut off.

1167. Q.—Assuming that a brake pipe reduction has been made, sufficiently heavy to equalize the pressures in the pressure chamber and the application chamber, what will be the result of a further brake pipe reduction?

A.—The control valve equalizing piston will have the pressure chamber air bottled up, as it can no longer expand into the application chamber, and as the brake pipe pressure is still lowering, the difference in pressure will soon cause the equalizing piston to compress the equalizing graduating spring and the valve will be moved to over-reduction position.

1168. Q.—What pressure does the pressure and application chambers equalize at?

A. 86 lbs.

1169. Q.—How much of a brake pipe reduction is necessary to produce equalization?

A. 24 lbs.

1170. Q.—With 86 lbs. in this cylinder as a result of the 24 lb. brake pipe reduction, what pressure will be obtained on other cars that do not have the P. C. equipment?

A.—60 lbs. brake cylinder pressure.

1171. Q.—How is a uniform retarding effect established with such an unequal brake cylinder pressure?

A.—The service braking ratio of the car with the P. C. equipment is based upon an 86 lb. brake cylinder pressure or to be more exact, on a 24 lb. drop in pressure in the service reservoir.

1172. Q.—What is the object of the higher brake cylinder pressure?

A.—Principally that a smaller brake cylinder may be used with a higher pressure instead of a larger cylinder with a lower pressure, the leverage ratio remaining unchanged.

1173. Q.—Does the release piston move at this time?

A.—No.

1174. Q.—Why not?

A.—Because the release piston graduating spring is stronger than the graduating spring of the equalizing piston.

(*To be continued*)

Car Brake Inspection.

(*Continued from page* 52, *February*, 1920.)

1063. Q.—What is the size of the brake cylinder and brake pipe branch pipes?

A.—4 in. for both.

1064. Q.—Which is the brake pipe connection?

A.—The lower one in the bracket.

1065. Q.—And the brake cylinder?

A.—The 1 in. connection nearest the brake pipe.

1066. Q.—What is the lower ½ in. pipe tap?

A.—The brake cylinder exhaust port,

1067. Q.—Which is the service reservoir connection?

A.—The extreme upper 1 in. connection.

1068. Q.—How is the auxiliary reservoir connection distinguished?

A.—By the ¾ in. connection.

1069. Q.—What is the 1 in. connection in the center of the bracket?

A.—The emergency reservoir.

1070. Q.—What is the 1 in. tap near this that will be found plugged with either one or two cylinder for service installations?

A.—A connection for the emergency brake cylinder when one cylinder is used for service and both for emergency.

1071. Q.—What is the ½ in. pipe tap just above the brake cylinder exhaust port?

A.—The pipe connection for the quick recharge reservoir when a small reservoir is used for emergency brake cylinder pressure.

1072. Q.—What is connected at this point when but one large emergency reservoir is used?

A.—There is no connection, this opening is closed with a ½ in. pipe plug.

1073. Q.—What modification is made in the pipe bracket when a large and small emergency reservoir is used?

A.—The emergency reservoir port on the quick action portion side of the bracket is closed with a ¼ in. pipe plug.

1074. Q.—And what is necessary if a small reservoir is removed and but one emergency reservoir used?

A.—This plug must be removed.

1075. Q.—What is the object in remembering these various pipe connections?

A.—It is of advantage in a case of accident when several of the pipes may be broken off or missing.

1076. Q.—What are the principal duties of the equalizing portion?

A.—To control the service operation of the brake and the charging of the reservoirs.

1077. Q.—And the quick action portion?

A.—To control the charging of the quick action closing chambers in the bracket, the emergency operation of the brake and the exhaust of brake pipe pressure for the propagation of quick action.

1078. Q.—And the high pressure cap?

A.—To control the development of a high emergency brake cylinder pressure and to provide for emergency operation upon a depletion of brake pipe pressure.

1079. Q.—What is the emergency reservoir check valve?

A.—Under the cap nut on the left hand side of the equalizing portion when facing it from the release piston side.

1080. Q.—And the service port check valve?

A.—The one on the right hand side, both being in the equalizing cylinder cover.

1081. Q.—Where is the service reservoir check valve?

A.—In the same cover next to the bracket when the equalizing valve is on the bracket.

1082. Q.—Where is the quick action charging check valve?

A.—At the top of the quick action portion.

1083. Q.—Where is the emergency check valve located?

A.—In the high pressure cap.

1084. Q.—Where is the graduated release piston?

A.—At the bottom of the equalizing portion.

1085. Q.—Where is the charging valve?

A.—Attached to the body containing the graduated release piston.

1086. Q.—Where is the graduated release cap?

A.—At the left hand side of the release piston structure, when facing the equalizing portion from the release piston side.

1087. Q.—How can it be determined whether this cap is in graduated or direct release position?

A.—By letters cast on the cover and valve body, which form the sentences "direct release" or "graduated release" according to the position of the cap.

1088. Q.—What if the letters cannot be distinguished?

A.—Two long lines or elevations over ports in the cap, converge to roughly form a letter V, the direction of the base or converging points of the V show the position of the cap.

1089. Q.—Where does this V point when the cap is in graduated release?

A.—Upward toward the equalizing cylinder cover.

1090. Q.—And when in direct release position?

A.—This V points toward the bottom or charging valve portion of the equalizing portion.

1091. Q.—How is the intercepting valve distinguished from the protection valve?

A.—The protection valve cap has port holes in it.

1092. Q.—Where is the high pressure or emergency valve located?

A.—At the bottom of the high pressure cap.

1093. Q.—How many exhaust ports has the equalizing portion?

A.—The emergency slide vale exhaust and the release slide valve exhaust ports.

1094. Q.—What other exhaust ports has the emergency or quick action portion and the high pressure cap?

A.—The quick action exhaust port, the emergency slide valve exhaust port and the protection valve exhaust ports.

1095. Q.—How is a universal valve cut out if found to be defective?

A.—By closing the stop cock in the brake cylinder branch pipe and the cut out cock in the brass cylinder pipe.

1096.—Q.—How cut out if the trouble is only with the brake rigging?

A.—By closing the stop cock in the brake cylinder pipe.

1097. Q.—Why leave the air pressure in the brake system?

A.—For the operation of the water raising system if one is in use.

1098. Q.—If it becomes necessary to bleed off a brake how should it be done?

A.—By opening the bleeder cock in the auxiliary reservoir and closing it as soon as the brake cylinder exhaust port opens.

1099. Q.—How is the slide valve unseated?

A.—The brake being applied with air pressure in the brake cylinders, the sudden removal of the pressure in the emergency recervoir removes the pressure from the release slide valve chamber before the equalizing portion can return to release position and the brake cylinder pressure under the release slide valve may unseat it.

1100. Q.—What will usually stop a blow or waste of air from the brake cylinder exhaust port or release slide valve exhaust port when air pressure is first turned into the system?

A.—Closing the brake pipe stop cock will usually then result in application of the brake and when the cock is re-opened the blow will stop, sometime it is necessary to make an emergency application of the brake in order to stop the blow.

(*To be continued*)

Rates and Living Costs

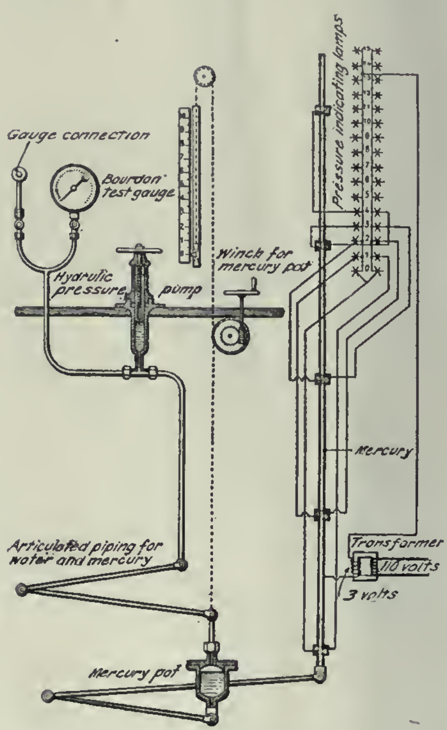
The fact is proved beyond all controversy that freight rates are so low compared with the value of most commodities that they exert very little influence upon their legitimate prices. Any examination and analysis of railroad figures will prove the correctness of this statement. *The trouble is that for ever so slight an advance in rates, the shipper or dealer feels warranted in adding a large increase to the price of the goods, and then laying the blame on the railroads.* For example, during the years 1914 to 1918 the Bureau of Labor Statistics shows that the wholesale price of commodities in the United States were 30 times as great in proportion as the increase in the average freight rate, the latter being 3 per cent. and the former 91 per cent. This demonstrates that in those four years the almost negligible increase in rates had almost no effect upon the average cost of living; and the same thing that was shown for 1914-18 would naturally be shown again in 1920-22. Yet in defiance of all established facts and figures, there are those who persist in the argument that any advance in rates will result in an addition to the cost of living five times as great as the advance in rates—a terrifying statement which is easy to make and apparently easy to induce credulous folk to believe, but absolutely impossible to prove by any argument based on operating figures or human experience. This should be apparent to any one who will take the least consideration in examining the available data on the subject.—Salt Lake (Utah) News.

Mercury Column for Calibrating Gauges

Le Geine Civil recently illustrated a design of mercury column for calibrating pressure gauges that does away with the long and expensive glass column and the necessity of taking direct readings from the same. The column under consideration was designed by M. Tavel of Lyon, France. For French service it is based upon the readings of pressure in kilograms per square centimeter, though, of course, it would be as applicable to read in lbs. per sq. in.

The column as designed for French use is formed of 25 sections of steel tubes having an inside diameter of almost ⅛-in. Each section has a length corresponding to a column of mercury exerting a pressure of one kilogram per sq. centimenter (about 14 lbs. per sq. in.). The sections are fastened together as shown in Fig. 2, by bolted flanges having steel washers between them. In each of the washers there are two small insulated nickle pins which run to the interior of the tube and are set about 1/16-in. apart between centers.

The outer end of each pin is connected by a wire to a small electric lamp set on the testing table. The column of mercury and the tube serves for the return circuit.

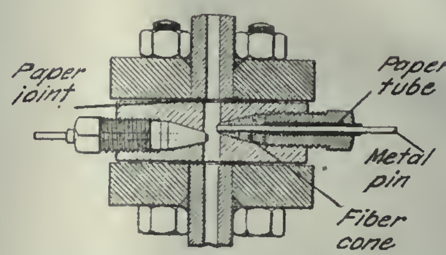


DIAGRAMATIC ELEVATION OF TAVEL APPARATUS FOR TESTING PRESSURE GAUGES.

In order to calibrate a gauge it is attached to the connection in the ordinary way, and then the handle of the pump (Fig. 1) is turned. This puts a pressure on the top of the mercury in the pot and forces it up through the tube until the first lamp is lighted and then the second. If the first lamp of a joint only is lighted, it is because the level of the mercury lies between the two pins, that is to say, less than 1/16-in. below the upper pin. It is then considered that a pressure of one kilogram has been obtained, because a column of mercury 1/16-in. high corresponds to only about ½ oz. per sq. in.

Increasing the pressure with the pump, forces the mercury higher and higher and calibration readings are taken as its level passes each joint.

If it is desired to take any intermediate pressures, the mercury pot can be raised or lowered about 33.5 ins. by means of the little winch. The zero of the column is thus displaced by the same amount. The column itself is calibrated and designed for service at a temperature of 68° Fahr.



SECTION OF TUBE AT CONTACT POINT OF TAVEL APPARATUS FOR TESTING PRESSURE GAUGE.

One of the incidental though by no means insignificant advantages of the construction is the small amount of mercury required to fill a column. For example, a column 50 ft. high which would be about what would be needed for calibrating gauges up to 300 lbs. per sq. in. would require only about 7¾ cu. in. or 3.8 lbs. of mercury, which, increased 50 per cent for the pot and connections would make a total of but 5.7 lbs. for the whole apparatus.

The Best Hope

The best hope of new railroads, in which Oregon is vitally interested, is the initiative and foresight of the men who developed the system to its present great, though now inadequate, proportions. *Given assurance of reasonable income to be derived from living rates by economical, efficient management, they would attract capital for improvement of existing lines, for construction of new lines and for purchase of cars and engines,* railroad men, with the stimulus of private enterprise, would build roads where traffic was in sight, not where the most votes in Congress could be mustered. It is high time that something approaching common sense and common justice should be applied to a subject of such great and growing importance as the American railroads.—Portland (Ore.) Oregonian.

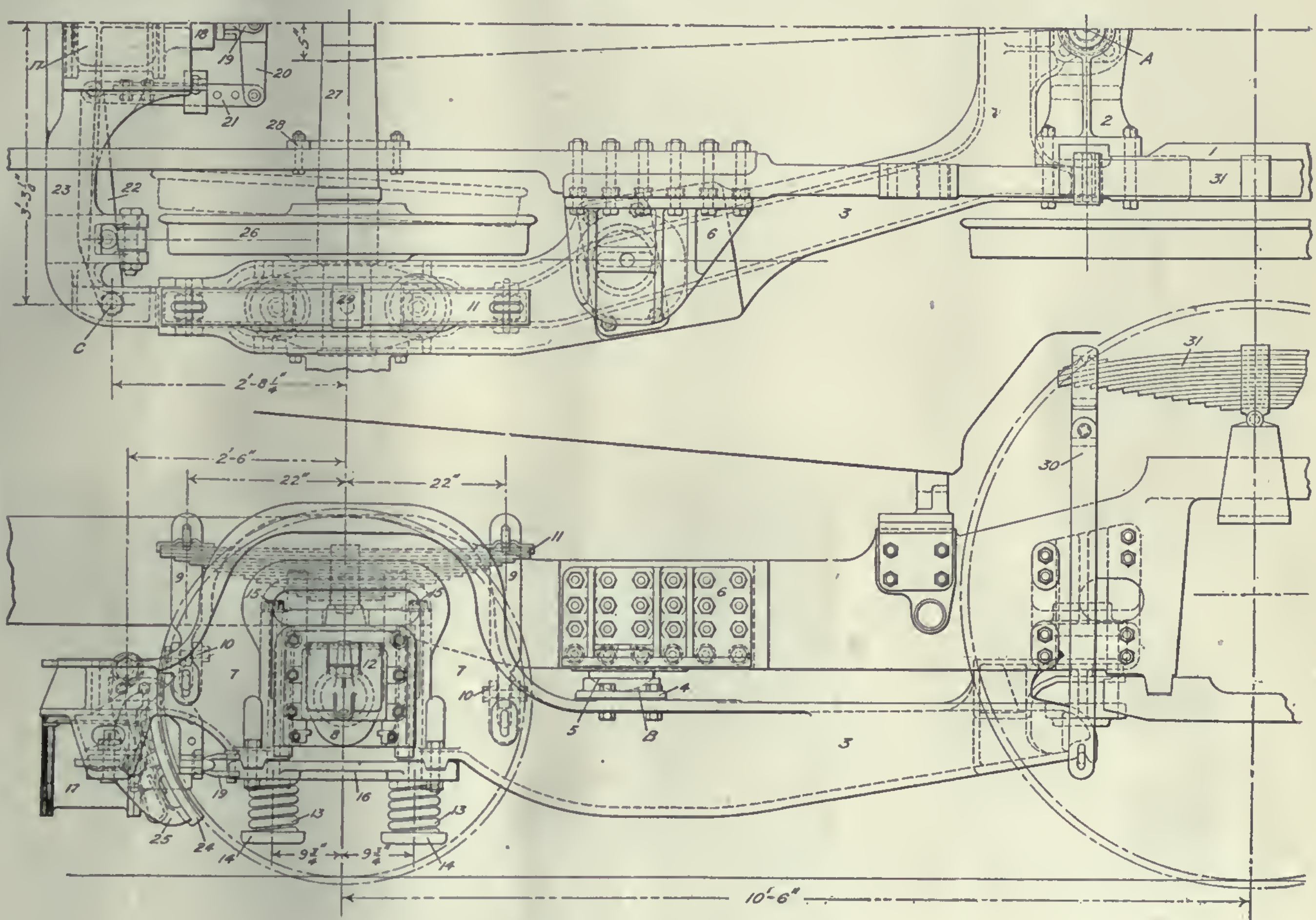
Details of Parts of the Pacific Type Locomotive as Shown in Our New Chart, No. 12

The trailing truck shown under the Pacific locomotive, illustrated by the chart, is of the pony type similar in construction to the pony trucks used under consolidation locomotives, but differing very essentially in its details. The radius bar, truck and driver equalizers, pedestal jaws and end piece of the truck are cast in one piece. The pivoted point of the radius bar is at the center of a cross brace of the engine frame at *A*. In the usual form of pony truck the equalizer between the truck and main frames lies on the center line of the engine and rests on the clutch pin of the truck. In this case the radius bar and equalizer or equalizers are in one piece and the engine frames are carried by ball and socket fulcrums at *B*, there being one on each side; while the truck frame is supported by the spring hangers and a semi-elliptic spring on each side. The main engine frame is carried by a bracket (6) bolted to the outside of the frame and having on the lower surface the fulcrum ball (5). The pedestals (7) arch over and hold the oil box in place and are carried by the spring hangers (9). The lower end of these spring hangers are attached to the pedestals by means of a clevis (10) that permits the hanger to take an angular position because of any lateral movement of the elliptic spring and oil box. The weight is also partially carried by the pedestal helical springs (13), which are suspended from the top of the box by the bolts (15).

As the truck has a lateral movement of 5 in. on each side of the center beneath the engine, a separate brake cylinder is required. This is placed on the center line of the truck and fastened to the truck end piece. The push rod acts against an equalizer (20), which in turn actuates the pull rod (20) that is attached to the brake lever, which is fulcrumed on the frame at *C* and so applies the brake.

The following is the list of parts of the truck:

1. Engine frame.
2. Engine frame brace.
3. Radius bar.
4. Equalizer fulcrum socket.
5. Equalizer fulcrum ball.
6. Equalizer fulcrum bracket.
7. Truck pedestals.
8. Oil box.
9. Truck spring hanger.
10. Truck spring hanger clevis.
11. Truck semi-elliptic spring.
12. Oil box cover.
13. Pedestal helical spring.
14. Pedestal helical spring seat.
15. Pedestal helical spring bolt.
16. Pedestal tie bar.
17. Brake cylinder.
18. Non-pressure brake cylinder head.
19. Brake push rod.
20. Brake equalizer.
21. Brake pull rod.
22. Brake lever.
23. Truck end piece.
24. Brakeshoe.
25. Brakehead.
26. Trailing wheel.
27. Trailing axle.
28. Axle safety hanger.
29. Spring band.
30. Driver spring hanger.
31. Driver spring.



DETAILS OF TRAILING TRUCK.

Electrical Department

Bakelite Micarta-D Gears and Pinions

Notes on the Durability of Non-Metallic Material

With the application of the electric motor to machine tool work, which has become nearly universal, there comes up the question of the best type of gearing. Ordinary gearing that is the pinion and gear both of metal, is noisy, and to over-

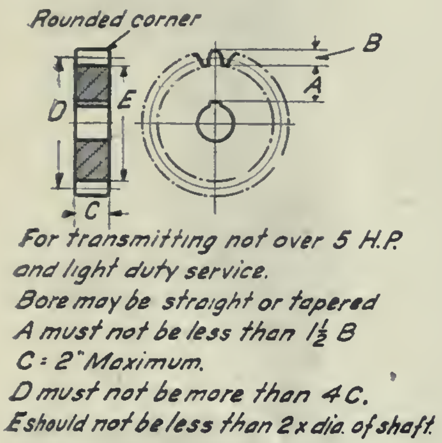


FIG. 1. BAKELITE MICARTA-D FOR SMALL SIZED MOTORS.

come and eliminate the noise, pinions of rawhide have been used. With the rawhide pinion, and all other non-metallic gearing except Bakelite Micarta-D, it is necessary to make the width of the face of the non-metallic material equal to the width of the face of the mating gear plus

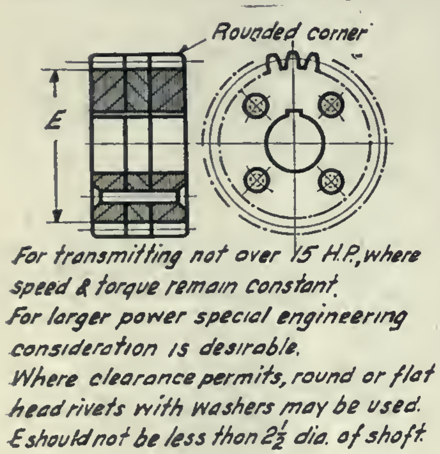


FIG. 2. FOR MOTORS UP TO 15 H. P.

aggregate end play of both shafts; otherwise the shrouds which are necessary to hold the non-metallic material, will mesh and the gearing will become noisy. A greater width must be used than is necessary to transmit the required power.

With Bakelite Micarta-D gears, even if it does become necessary to use end plates for additional hub strength, the teeth need not be shrouded and the width of the gear is determined only by the power to be transmitted. On account of this fact, Bakelite Micarta-D gears can be used for many special applications where the use of any other non-metallic gear would be impracticable, such as a 2-inch face pinion meshing with a 7-inch face fly-wheel.

Bakelite Micarta-D is a non-metallic material. It can in general be advantageously substituted for untreated steel, cast iron, bronze or rawhide. It has many distinctive advantages. It is the only non-metallic gearing material that is self-supporting. It is not affected by water and can be operated in oil without any signs of swelling. Its water absorption is practically zero.

The material is manufactured in plates or sheets approximately 36 inches square and in thickness up to 2 inches. It can be moulded into rings. The gear blanks are cut from the plates and the teeth then milled.

The Bakelite Micarta is made up of layers of cloth held together by the bakelite so that it is a solid mass, which can be machined and worked as is a metal.

The physical properties obtained from a large number of laboratory tests are interesting and are as follows:

1. Tensile strength, parallel to laminations—10,000 pounds per sq. in.

2. Compression strength, perpendicular to laminations—35,000 pounds per sq. in.

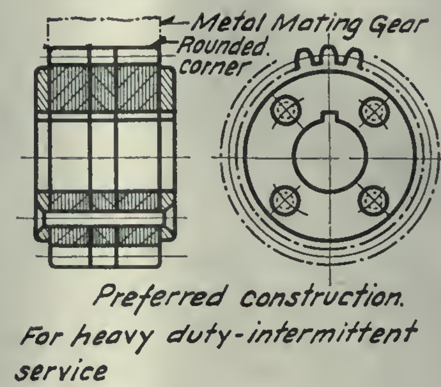


FIG. 3.

3. Compression strength, parallel to laminations—17,000 pounds per sq. in.

4. Transverse strength, maximum fiber stress both parallel and perpendicular to laminations—17,000 pounds per sq. in.

5. Coefficient of expansion per inch per degree Centigrade—.00002-inch in the direction parallel to the laminations and .000085-inch in the direction perpendicular to the laminations.

6. Specific gravity—1.4.

7. Weight per cubic inch—.05 pounds.

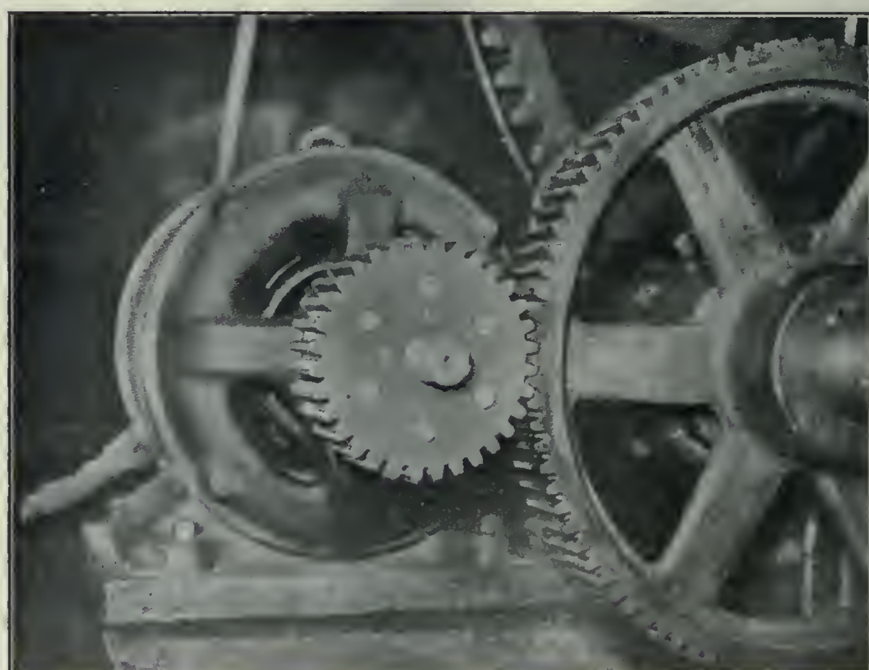


FIG. 4. PINION FOR DRIVING PUNCH PRESS; 4 DP. 32 TEETH ON 7½ HORSE-POWER MOTORS

8. Shrinkage is practically zero up to a temperature of 100° C.

Under ordinary circumstances the gears are designed not to exceed stresses higher than 5,000 pounds per square inch and is the same figure which is ordinarily used in designing rawhide gearing. If this figure is not exceeded, where operating conditions are normal, long life and exceeding satisfactory operation will result. The material can be used with fibre stresses as high as 15,000 pounds per square inch, but the wear will be excessive and replacement will be necessary after a few months service rather than after a few years service.

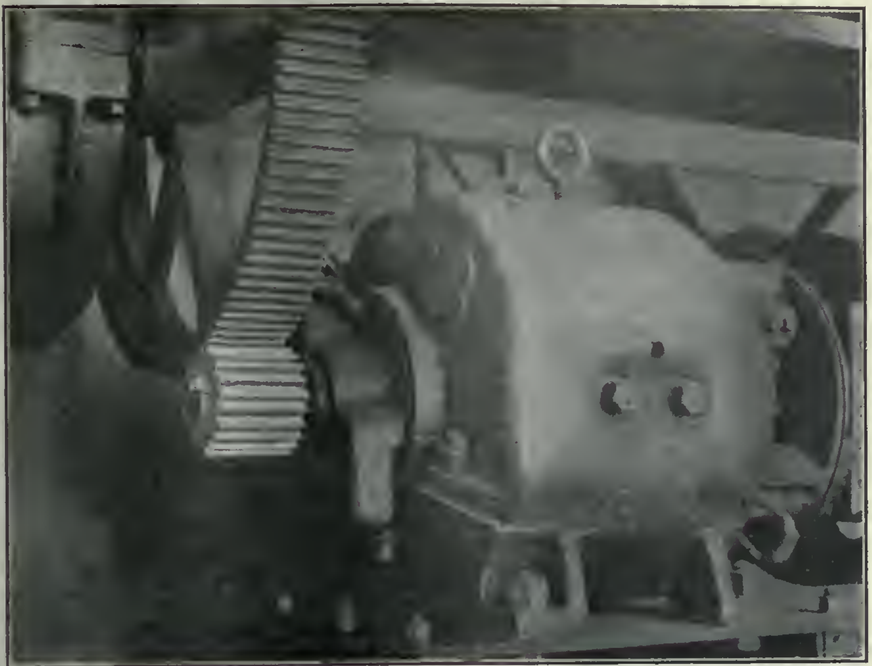


FIG. 5. PINION ON CRANE MOTOR.

The material is generally made up into pinions and are meshed with metal gears. It is essential that both sets of teeth be cut true and lined up accurately, also mounted on proper centers.

The Bakelite Micarta-D gears should be well lubricated and a heavy graphite grease is recommended. The standard construction is shown by Figs. 1 and 2. The construction as shown by Fig. 1. is limited to 2 inches since rivets are not used. The construction as shown by Fig. 2 may be used for gears up to 35 inches in diameter. Rivets are used on medium-sized gears but for large gears, say of 30-inch diameter by 20 inches face, rivets are impractical so that through bolts would be used. For heavy duty intermittent service, plates are used with the rivets, as shown by Fig. 3.

Fig. 4 shows a pinion which had been in service ten months with practically no wear. Another application is shown by Fig. 5. Rawhide pinions were formerly used and required replacement every six or eight weeks. The pinion shown in photograph has been in service two years with little sign of wear, thereby proving that the durability of the material has been established.

Snap Shots

By the Wanderer

It is sometimes dangerous for a passenger agent or the superintendent of a dining car service to invite criticisms and suggestions from the traveling public. To be sure they are apt to get the criticisms all right, but they may be of the sort that are difficult to remedy and not too flattering to the complacency of the manager who thinks that he has done things just right. As an evidence of this I am privileged to cite a couple of letters that were sent to superintendents on just such invitations. Of course, it will not do to name the names of the writers or the recipients.

One was in comment on a circular issued to prove that my road is the best on earth and the other in response to a menu invitation to report incivilities and unsatisfactoriness, etc. In justice to the recipients, however, it may be added that the writers were informed that the most strenuous of efforts would be made to remedy the defects. Here followeth the documents:

"I have read with great interest the pamphlet that you have recently issued setting forth the attractions of your line and especially that part of the first paragraph where you say that your high speed expresses make their marvelous time between Scandinavia, Calcutta and Boston, day in and day out like clockwork. Let me see! Was there not a king of England who once started to make a half dozen clocks run alike and failed? Yet it is splendid to see how your employes upheld your assertion and the reputation of the road. They one and all were unanimous in their assertion that No. 26 was almost always right on time to the dot, that is to say (always arrived sometime during the morning, in fact it was very rarely more than an hour behind the schedule. Of course, sometime during the day is quite on time according to the ideas of the tropics, and why be in such a hurry and quibble about such a little matter as an hour or so any way? That telephone service too is fine, because people are so forgetful that there is no telling what final message they may want to send and it is so much more fun than sending a picture postal besides being up to date.

"I want to congratulate the service, too, on their paper bags for ladies' hats. They are great and the solicitude of the porter in distributing them is really pathetic. He is so anxious that every one should have them, and then he dangles around and still continues dangling to see how they enjoy them. Some people seem to think that he's waiting to be paid for them in the form of a tip, but that can't be, for the moment one is offered he looks so abashed and goes away at once. Of course, he takes the tip probably because he doesn't want to hurt the passenger's feelings.

"It seems to me, however, that it is very wasteful to use them, for really there is no more dust in the cars than there is on the rear platform. And it is so evenly distributed and settles down in such a nice even layer that in a few miles everything assumes a smooth, even brown tint that is very artistic. Breathing is, of course, possible all through the trip, and the only suggestion I can make for the improvement of the service is that air filters be provided for respiration purposes, of course with due modifications to the feelings of the porter for his efforts in distributing them, like the hat bags.

"This idea of not disturbing passengers in the morning is also fine. The hint that it is his breakfast that is the crucial thing is the acme of refinement, besides it serves to remind the passenger that there is a dining car on the train which he ought to be eager to patronize, an eagerness that is of course enhanced by the knowledge that it is a different one from that in which he dined the night before. The recollection of the experiment with what he had would surely urge him to rise betimes. That roast which reminded him so of that delightful bon mot of the cook in Why Smith Left Home, to the effect that she 'cud take the tinderest pace av bafe ye iver saw an cook ut so that ye'd shware ut was the bottom iv a sole leather thrunk.' The bread so crisp on one side that made spreading so easy. The potatoes done in water instead of milk, for really this cooking vegetables in milk is a rank waste and absurdity, it makes them so palatable and you eat so heartily as to lose all appetite for dessert. And the 'pot' of cocoa. It comes on so beautifully that you are eager to pay for it, utterly oblivious to the fact that you only get a scant cupful. And finally the milk, of a shade so blue and clear that you are reminded of the Bowery with all its life and vivacity, and feel thankful that you are not asked to drink that awful yellow stuff one gets in the country. The only thing to mar the recollection is the insistence of the waiter that the fresh vegetables were canned, and that the excessive use of pepper was due to carelessness on the part of the canner and not to the generosity of the company and the cook. He evidently thought that too much pepper spoiled the food and would protect his fellow from every imputation of lack of skill even at the expense of his own veracity. I know he was wrong because the menu said that the vegetables were fresh.

"Then the beauty of the cars in the evening with their decks dotted with the tiny bulks of light emitting firefly gleams, and the interest there always is in watching the passengers who are trying to read, when their berth lamps will not work as mine would not. One gets thereby a high opinion of human perseverance. Then before we retire we have a fine long entertainment in bed making by the porter who works constantly and unceasingly for three hours in tucking his passengers away for the night. Then the *lever,* the delights of the toilet, where a carload of twenty odd passengers share three basins between them, and as fast as one has completed his toilet he sits down in the room to watch the rest, though where the interest in such a proceeding lies I do not quite understand. Of course, some of this solicitude is due to the fact that the porter is more interested in brushing off and collecting tips than he is in making up berths and contributing to the real comforts of the passengers so that if they wish to sit down the wash room is the only resort.

"Then, when it comes to incivility in the dining car, there is very little of that, but I am going to take the request to report dissatisfaction as one to cover all points. So I am calling your attention to a few things, and among them is the inattention paid to minor matters on your dining cars.

"They are confessedly very small, but they just serve to cause irritation and discontent. For example, I was on your train No. 5 on a recent Sunday. For my supper I ordered chops, well done, and a glass of milk. I wrote 'well done' on the card. They came crisp on the outside and quite red inside, and the milk was sour. The sourness was due not to the oldness of the milk but to the fact that the vessel containing it had not been properly cleansed. I returned on your No. 4 a week or more later. For breakfast I ordered 'boiled eggs (3½ minutes)' and a cup of cocoa. Before ordering the latter I asked the waiter if it would be made with milk or water. He replied, 'Milk.' My eggs were served hard boiled and the cocoa was slop; just a spoonful of cocoa stirred in hot water.

"You say, 'Why not speak to the conductor?' Well, I've had experience. If I had sent the chops back, the cook would have been angry and burned them to a crisp, and they would have been worse than before.

"The milk was bad and probably there was no other on the car. The waiter did acknowledge that there was a mistake about the eggs, but made no offer of refilling the order. The cocoa was probably made in accordance with orders from above, so why go for a subordinate, though I did feel that when 15 cents is charged for a cup of cocoa you could at least afford to put in two cents worth of milk. No, there is no use talking to the subordinates. They are merely politely apologetic and the passenger is more annoyed than before. To put the matter plainly, you are the responsible party, and it is to you that we must look for the jacking up of the service and the removal of the annoyances that leads other passengers to do as I did both in going to A and returning to B. That is, wait until I had reached destination before taking my second meal rather than subject myself to their little pin-pricks that detract so much from one's comfort while traveling.

"I feel that I ought to apologize for bothering you with such petty trifles as those which I have detailed, but I know that when you enter one of your cars, "It is the King," and it passes down the line that you are there, and as they say at sea: 'All hands and the cook,' are banded in an attempt to make you happy and to smother the growls of the man at your elbow, for whom they have scant regard. You remember the saying of the old sculptor, who devoted what his friends thought unnecessary pains to the minor details of his work, 'the trifles' they called them. 'Yes,' he said, 'but it is the aggregation of trifles that make perfection, and perfection is no trifle.'"

Pittsburgh A. I. E. E. Meeting.

Electric traction subjects discussed at the Pittsburgh meeting of the American Institute of Electrical Engineers on March 12, elicited quite a little interest because of the widely varying views of the engineers present. This meeting which was held under the joint auspices of the Pittsburgh section and the Traction & Transportation Committee began in the morning with an inspection trip through the Westinghouse Electric & Manufacturing Company and ended with a dinner in the evening. During the inspection trip which was taken by 200 men, the visitors were shown one of the Baldwin-Westinghouse electric passenger locomotives for the Chicago, Milwaukee & St. Paul, and the automatic substation equipment now being built for the Cleveland Railways Company. After a luncheon at the plant, the party went direct to the afternoon session where the automatic equipment and converter operations were discussed. Papers were presented by Marvin W. Smith and R. J. Wensley, Westinghouse Electric & Manufacturing Company, entitled respectively, "Flashing of 60-cycle Synchronous Converters and Some Suggested Remedies" and "Automatic Substations for Heavy City Service," and by J. J. Linebaugh and Frank W. Peters, General Electric Company, entitled respectively, "Short-Circuit Protection for D. C. Substations" and "Automatic Railway Substations." These papers were discussed by F. D. Newbury, S. Q. Hayes, D. C. Hershberger and C. A. Butcher, Westinghouse Electric & Manufacturing Company; C. M. Davis, J. F. Tritle, General Electric Company; Donald Bowman, Commonwealth Edison Company, Chicago; C. H. Jones, Chicago North Shore & Milwaukee Railroad; and L. D. Bale, Cleveland Railways Company. The question of flash barriers for synchronous converters caused quite a little discussion, one group recommending their use and another saying they should be avoided if possible.

The two designs of electric passenger locomotives for the Chicago, Milwaukee & St. Paul Railroad were described at the evening session by N. W. Storer, Westinghouse Electric & Manufacturing Company, and S. T. Dodd, General Electric Company.

Lathe Centers.

The Ready Tool Company, Bridgeport, Conn., has recently placed on the market their new high-speed lathe centers. The particular feature of the improvement in the device is in the welding of a piece of high-speed steel which runs back about one-quarter of the distance from the point, which, of course, is all that possibly could be used. The weld is made with the company's guaranteed Red-E-Electric process, which insures the highest conductivity. One other important feature is that there are no parts to lose, or misplace, or oil holes to get clogged up. They have already been adopted by several of the leading machine manufacturers, and after very exhaustive tests are claimed to last from twenty to fifty times between grindings. They will not only not burn or freeze to the work, but their use enables operators to run lathes to the highest speeds with a degree of endurance more than thirty times that of carbon centers. The company's reputation for cutting tools, tool holders, reamers, and other machine tools is of the highest, and in addition the renewing of old shanks, flat, square or round, with new cutting ends has effected considerable economics in the company's chosen field of mechanical activity.

READY TOOL COMPANY'S HIGH SPEED LATHE CENTER

Corrosion in Heating Pipes.

F. M. Speller, of the United States Bureau of Mines, in the *Journal* of the Franklin Institute, gives some information on the prevention of corrosion in heating pipes. He says that pipes for hot water heating do not suffer seriously if the same water is circulated repeatedly, but the corrosion becomes rapid if much make-up water is added, especially in districts where the water is soft. In systems using open heaters, where the water was allowed to come to rest at 180° F. or higher, thus discharging the gases, the pipes showed practically no corrosion in ten years' service. In another system a storage tank filled with expanded steel lathing was used. Practically all the free oxygen was removed in the tank, and in three years there was practically no corrosion in the pipes.

Old Material Renewed.

It has always been the object, the *Technical Review* reminds us, of German railway management to reduce the cost of upkeep, but in the present conditions it is more essential than ever before.

The article, which it condenses and translates, is especially concerned with damaged bolts and nuts from the permanent way—these formerly went direct to the scrap heap. The methods for preventing this waste, which have been devised by Mr. Gerz, of Witten, deserve publicity. Bolts in which the thread had been worn were straightened, the defective part cut off, and rethreaded, thus making a perfect bolt of a shorter length. The nuts, when rusted on, were cut off, heated in a furnace to loosen them on the bolt, and then retapped. In some cases nuts and bolts can be heated in a gas furnace, so that when hot they can easily be separated.

The author says that the process employed will remind the reader of those invented by Mr. Wegener, in which old bent parts were heated, pressed back to their original shape ,and reused. These combined processes have saved the railway management very large sums.

A Hopeful Outlook.

The magnitude of the task in rehabilitating the railroads now that they are back in the hands of the owners is so colossal that it will be some time before any perceptible change can be expected. Changes will be brought about gradually after careful consultation by the joint councils of railroad managers. The roads were bad enough before the government took them over, the deadening effect of the repressive acts of the Interstate Commerce Commission had not only reduced two-thirds of the railroads to bankruptcy, but kept them there. To meet the present conditions an increase of rates approaching to 20 per cent is necessary, and if any good at all has come out of the experience of the last two years it will be in the spirit of readiness with which the controlling commission allows the needed increase. The rest may safely be left to the railroad men. New investors cannot be expected in any great numbers until there is a visible assurance of a surplus to meet on equal terms with the common rates of interest accruing to other properties. The fact that the transportation rates in operation in America are the lowest that prevail in any part of the world seems to have fallen upon inattentive ears, in view of the clamor raised by the insistent scandals of stock watering, which might have had some modicum of truth in them in the railroad operations of the last century, but could not escape the eyes of the authorities in our own day. Hence while we cannot reasonably expect immediate and amazing improvements, we can look forward hopefully toward an assurance of a marked progress in the right direction.

Domestic Exports from the United States, by Countries, During January, 1920.

STEAM LOCOMOTIVES.

Countries	Number	Dollars
Azores and Madeira Islands	3	75,300
Italy	60	2,280,000
Canada	7	16,341
Panama	1	2,085
Mexico	3	32,250
Cuba	36	912,425
Dominican Republic	1	2,216
Argentina	3	21,000
Brazil	24	596,200
Venezuela	1	15,600
China	2	20,000
Dutch East Indies	3	149,520
Philippine Islands	2	36,277
Total	146	4,159,214

United States Patent Applications.

Records of the United States patents granted in 1919 are now available, and, notwithstanding the economic position of the country at the present time, it is surprising to find that the number of patents granted in 1919 was less than in 1918; in fact, last year carried on the decrease which began in 1916. This course is the opposite to that followed by invention in this country, in which the applications and patents granted thereon, although they received a temporary check in the autumn of 1914, have gradually increased during the last few years.

The actual numbers of patents granted in the United States for the past seven years are as follows:—

1913	33,941
1914	39,945
1915	43,207
1916	43,970
1917	41,069
1918	38,569
1919	36,872

In Great Britain for the same period the figures ranged from 30,102 in 1913 down to 18,225 in 1915 and increased to 32,892 in 1919.

As the number of patent applications varies approximately with the trade of the country, it is difficult to understand why the fall should occur in the United States; but there is a possible reason, in that the patents granted in any given year in America are not wholly patents based on the applications lodged within that year, because it takes several years in many instances for a patent to be granted, so that many of the 1919 patents were based on applications of some years' standing, and many of the 1919 applications have not yet matured into patents.

Indeed some of them, to our own knowledge have taken as long as five years, and in some cases the inventor had passed to the silent land.

The Labor Situation.

At the meeting of the Central Railway Club, on March 12, Frank H. Hardin, in the course of an address on the labor situation, said that it is recognized that it is not possible to realize the same production in the eight as in the ten hour day, but had this been possible it would not have been necessary to increase prices, the cost of living would not have increased, the value of the dollar would not have decreased, and the world in general, but the laboring man in particular, would have been greatly benefited. As long as wages are advanced and production decreases or even remains the same, the cost of living must necessarily increase and the circle becomes endless. It is absolutely impossible for the laboring man to make headway against the cost of living by the methods that are being followed today. The one and only relief is increased production. Germany has already realized this fact and her workingmen have voted for the eleven hour day in order that production may meet the demands and again permit them to wage the fight for commercial supremacy. How this increased production is to be obtained in America, however, is the real problem of the present time.

It is apparently necessary first to stimulate production by creating an incentive to produce. We cannot today outline a method that may be pronounced "best," but some manufacturing concerns are now trying methods which will, no doubt, create an interest on the part of the employes in the success of the business. It will probably be very difficult to apply any plan that is being tried at the present time to the railroads on account of the diversity of the work and the extent of the territory they cover, but out of the numerous plans that are being tried one should be evolved which will gain the desired results and the mutual efforts of employers and employees along these lines can, without question, create a successful plan.

In connection with any campaign to increase production it will be necessary to undertake a thorough and systematic education, applied particularly to those who have come to us from foreign countries and who speak our language but poorly, and who do not understand our institutions and our ideals. Their very misunderstanding creates fertile soil for the growth of radical ideas that are the subject of a systematic and universal propaganda today.

Railroad Rates.

It will be generally admitted that the railroads must soon adopt a clear and definite policy as to the needful alterations in traffic rates. The directors of many roads are holding meetings in these closing days of the governmental railway régime, and the question of rate revision presses to the front, before all the concerns that attend the return of the owners to active control.

No one in the country who has given careful consideration to the railroad problem from any angle, public, capitalistic, unionistic or communistic for that matter, contests the point that the roads under private ownership and operation must have more revenue if they are to meet their debt obligations and maintain the degree of credit requisite to their growth. It does not follow that they can directly obtain their conceded needs. To get the rates to which the Cummins-Esch railroad measure, once signed, will entitle them, they must take the initiative. In order to get the best possible adjustment of rates out of that amount of money which the nation can be called upon to yield up in added tariffs, they must take combined and orderly action.

Jig Designing.

It practically goes without saying that the designer of jigs, etc., should be well up in engineering shop practice and have a good general knowledge of foundry and pattern-shop work. It must be constantly borne in mind that before any jig, fixture, or like device has run its allotted course, it will experience all sorts of rough handling and usage. This human factor must always be reckoned with, and the tools designed to withstand a certain amount of abuse through this source. To meet this condition, it may often be necessary to construct on much stronger and stiffer lines than what may be actually demanded by the work in hand; of course, lightness is one of the essential features in their design, but a slight increase in weight, strength and rigidity at the beginning comes out much cheaper in the end, when the possibility of replacements and loss of time due to inherent weakness is considered. Reference has already been made to the designer's need of being conversant with the general arrangement of plant. In particularizing the lay-out of the machinery, rough sketches should be made, giving existing limits of the various machine tools, etc., with any other information necessary to ensure the jig or fixture being designed to conform to these. Such data should cover positions and sizes of those tee-slots, holes, registers, etc., etc., usually provided for clamping down, or other purposes, in order that these provisions may be utilized to the best advantage, where the need of fixing the work to the machine arises. The omission of holes or slots in the jig or fixture that requires securing is by no means of rare occurrence; if it only provided a vent for caustic comment on the part of the shop the fault would not have the same significance. What it does, however, is to give the workman a more or less free hand in deciding the method of holding the tool on to the machine. The result is, that many an otherwise well designed tool has been given the appearance of a make-shift job, due to unsuitable clamps or similar devices being applied. Such measures are not only unsightly but also, as a rule, crude and cumbersome and much time will always be lost in dismounting, for it must be remembered, the tool may have to be removed from the machine several times before the job is completed; or the batch of material may run out, and no more be immediately forthcoming, so that that particular operation will have to give way to some other, in order that the machine can be kept going. Then, again, the safety of the operator calls for special attention; unauthorized clamps ask for trouble in this respect, therefore not only is their omission bad design, but positively dangerous in cases where moving parts have to be considered. A little extra thought in the designing stage is time well spent, if it secures an efficient clamping arrangement and protects the machinist from accident. —*The Practical Engineer.*

New Coast Railway in Cuba.

During the year work proceeded on the construction of the Cuba Northern Railroad, familiarly known as the North Coast Railroad, and its line was completed from Moron along the coast to Nuevitas in the spring of 1919. This road was built by Cuban interests, and was rather heavily subsidized by the Government. It is understood that it will eventually construct a line from Moron to Caibarien, and it already has a branch connecting Moron with the main line of the Cuba Railroad at Ciego de Avila. Its operation will serve to bring sugar for export through Nuevitas from the territory around Moron and the western part of Camaguey Province. This movement started in the spring of 1919. The road will also open up a section of Cuba which has been hitherto practically untouched.

Railway Extensions in Persia.

Nearly 200 miles of new railroad have been completed in Persia on the Afghan frontier, and tapping the fertile districts around Herat, the granary of Central Asia. Many new schemes are being discussed and internal railway development is likely to be carried on under the Anglo-Persian agreement, if the Persians themselves seize their opportunities. At present, Bombay is the chief entry port for East Persia, but the overland route from the west is the hope of the future development in Persia and which was fully discussed in a recent issue of Railway and Locomotive Engineering setting forth the prospects of an early development in the railroads in Eastern countries.

Items of Personal Interest

L. G. Plaisted has been appointed night roundhouse foreman on the Rock Island, with office at El Reno, Okla.

W. P. Murphy has been appointed road foreman of equipment on the Rock Island, with office at Shawnee, Okla.

James Metzger, chief inspector at the Jersey City, N. J., roundhouse, has been appointed roundhouse foreman.

G. Dempster has been appointed master mechanic of the Southern railroad, in Mississippi, with office at Columbus, Miss.

George C. Jones has been appointed general road foreman of engines on the Atlantic Coast Line, with headquarters at Florence, N. C.

J. E. Brogan, master mechanic of the Atlantic Coast Line at Waycross, Ga., has been appointed superintendent of shops at Waycross.

J. T. Stewart has been appointed road foreman on the Santa Fe, with office at Las Vegas, N. M., succeeding C. H. Chambers, promoted.

Gus L. Hegberg has been appointed roundhouse foreman on the Rock Island, with office at Shawnee, Okla., succeeding F. J. Farmer, resigned.

C. H. Chambers, road foreman of engines on the Santa Fe, at Las Vegas, N. M., has been appointed assistant air brake instructor at La Juanta, Col.

R. R. Herrick has been appointed master mechanic of the Detroit, Bay City & Western, and the Port Huron Southern, with office at Bay City, Mich.

James M. Coble has been appointed shop superintendent of the Buffalo, Rochester & Pittsburgh at Rikers, Pa., succeeding W. W. Scott, resigned.

R. R. Herrick has been appointed master mechanic of the Detroit, Bay City & Western, and the Port Huron Southern, with headquarters at Bay City, Mich.

W. J. Skelton, roundhouse foreman of the Missouri, Kansas & Texas, at Denison, Tex., has been appointed general foreman, succeeding B. C. Nicholson.

F. H. Moore has been appointed assistant master mechanic of the Maritime district of the Canadian National Railways, with headquarters at Mondu, N. B.

John Vary has been appointed locomotive inspector on the Grand Trunk lines west of Detroit, and St. Clair rivers, with headquarters at Milwaukee Junction, Wis.

A. G. Williams, manager of the export department of the American Steel Foundries, Chicago, Ill., has sailed from Seattle, Wash., on a business tour through China and Japan.

George Bradshaw, supervisor of Safety on the Grand Trunk Western Lines, has resigned, and the work of the safety-first movement will be conducted by the safety committee of the road.

B. J. Farr, superintendent of motive power and car department of the Grand Trunk Western Lines, has changed his headquarters, formerly at Detroit, Mich., to Battle Creek, Mich.

J. W. Sutherland has been appointed assistant roundhouse foreman on the Santa Fe at Ottawa, Kan., succeeding Frank Childers, transferred to a similar position at Topeka, Kan.

J. E. Burke, formerly roundhouse foreman of the Chicago & Alton at Bloomington, Ill., has been appointed roundhouse foreman of the Kansas City Southern at Pittsburg, Kans.

C. M. Rogers, formerly supervisor of stationary plants on the Chicago, Rock Island & Pacific, has been appointed manager of service of the Locomotive Fire Box Company, Chicago.

C. D. Kinney, master mechanic on the Boyne City, Gaylord & Alpena, with office at Boyne City, Mich., has been promoted to superintendent of motive power, with headquarters at Boyne City.

W. N. Mitchell, formerly master car builder on the Missouri, Kansas & Texas, has been appointed superintendent of the car department on the same road, with headquarters at Denison, Tex.

C. A. Conner has been appointed traveling engineer and trainmaster of the Green River division of the Denver & Rio Grande, with office at Helper, Utah, succeeding C. H. Wilcken, resigned.

B. C. Nicholson, general foreman of the Denison locomotive shops of the Missouri, Kansas & Texas, has been appointed mechanical efficiency inspector, with headquarters at Parsons, Kans.

F. K. Tutt, acting master mechanic of the Missouri Pacific, at St. Louis, Mo., has been appointed mechanical superintendent of the Missouri, Kansas & Kansas, with headquarters at Denison, Tex.

George Searles has been appointed master mechanic of the Arizona division of the Atchison, Topeka & Santa Fe, with headquarters at Needles, Cal., succeeding Charles Raitt, assigned to other duties.

F. A. O'Neill has been appointed road foreman of engines of the Erie, with headquarters at Cleveland, Ohio, succeeding J. E. Bleutge, appointed traveling engineer with the American Expeditionary Forces.

L. L. Lambeth has been appointed master mechanic on the Mobile division of the Mobile and Ohio, with office at Whirtler, Ala. N. Q. Dougherty, master mechanic of the St. Louis division, with office at Jackson, Tenn.

Paul Linthicum, assistant shop superintendent of the Rock Island, at Silvis, Ill., has been appointed master mechanic at Estherville, Ia., succeeding S. E. Mueller, transferred to Silvis as assistant shop superintendent.

D. W. Fraser, managing director, Montreal Locomotive Works, Montreal, has been appointed vice-president in charge of sales, American Locomotive Company, with office in New York, N. Y., succeeding J. D. Sawyer, retired.

H. P. Wingert, formerly general purchasing agent of the American Brake Shoe & Foundry Company, has been elected president of the American Commodities Company, with offices at 30 Church street, New York.

L. E. Fletcher, master mechanic on the Atchison, Topeka & Santa Fe, at Raton, N. M., has been transferred to the Arkansas River and Colorado division, with headquarters at La Junta, Colo., succeeding H. Drake, assigned to other duties.

J. F. Surridge, recently discharged from the United States army, where he served as major in the 35th Engineers, has been appointed superintendent of the car department of the American Steel Company of Cuba, with offices at Havana, Cuba.

C. P. Patrick, general inspector on the Erie, has been appointed general manager of the Chicago Wilson Welding & Repair Company, with headquarters at Chicago, succeeding E. S. Fitzimmons, appointed sales manager of the Flannery Bolt Company, Pittsburgh, Pa.

George Henry Nowell has been appointed master mechanic on the Lethbridge division of the Canadian Pacific, with office at Lethbridge. Previous to his appointment as noted, Mr. Nowell was master mechanic on the Nelson division, British Columbia district, at Nelson.

Benjamin Franklin Bush, regional director of the Southwestern region, United States Railroad Administration, has been elected to his former position as president of the Missouri Pacific. Mr. Bush has had a wide experience chiefly in the engineering department of the western railroads.

Colonel C. N. Crawford has been appointed manager for the Baldwin Locomotive Works at Rio Janeiro, Brazil. Mr. Crawford, in addition to his duties as manager, will report from time to time on the various technical phases of engineering in relation to the needs of South and Central America.

G. E. Johnson has been appointed master mechanic of the Chicago, Burlington & Quincy, with office at Sherwood, Wyo., succeeding F. E. Kennedy, deceased; J. B. Irwin, master mechanic at Alliance, Neb., succeeding G. E. Johnson; C. E. Welker, acting master mechanic at Carper, Wyo., succeeding J. B. Irwin.

G. W. Cundiff has been appointed road foreman of engines on the Jackson division of the Mobile and Ohio, Southern Railway Company of Mississippi, with office at Jackson, Tenn., and A. J. Meriwether has been appointed road foreman of engines on the Mobile division, with office at Meriden, Miss.

C. H. Chambers, road foreman of engines on the Santa Fe, at Las Vegas, N. M., has been appointed assistant air brake instructor, with headquarters at La Junta, Col., succeeding M. O. Davis, resigned. Mr. Chambers will have jurisdiction over the Western Arkansas River, Colorado and New Mexico divisions.

W. C. Hunter has been appointed air brake inspector, Eastern Lines, Canadian National Railways. Mr. Hunter has had nearly forty years' experience as chief in the air brake department. He has been closely identified with the Air Brake Association, and at one time was second vice-president of the association.

F. M. Crandall, assistant master mechanic of the New York Central Lines west of Buffalo, with office at Collinwood, Ohio, has been appointed master mechanic with headquarters at Ashtabula, Ohio, with jurisdiction over the Franklin division, including the Oil City branch, Ashtabula and Youngstown yards, and the Alliance division.

F. O. Walsh, superintendent of motive power of the Atlanta & West Point, Western railway of Alabama, and Georgia railroad, announces the appointment of the following officers: R. P. Smith, mechanical engineer, Augusta, Ga.; W. H. Eager, Jr., electrical engineer, Montgomery, Ala.; J. H. Garten, master mechanic, Montgomery, Ala.; John Sheen, master car builder, Montgomery, Ala.; O. H. Attridge, master mechanic, Georgia railroad, Augusta, Ga., and G. K. Williams, fuel agent, Atlanta, Ga.

J. M. Hannaford has been elected president of the Northern Pacific. Mr. Hannaford entered railway service on the Central Vermont in the general freight offices at St. Albans, Vt., in 1866, and in 1872 entered the service of the Northern Pacific, and has filled many positions in the transportation department, including chief clerk, assistant general passenger agent, general freight agent, assistant superintendent, traffic manager. In 1902 he was elected third vice-president, and 1913 second vice-president, which position he held until the taking over of the railways by the United States Railroad Administration, and during this period he was Federal manager of the Northwestern region. Mr. Hannaford is also president of the Northern Pacific Express Company.

Richard Lincoln O'Donnel has been appointed president of the Pennsylvania. Mr. O'Donnel graduated from the Polytechnic College at Philadelphia in 1882, and entered railway service the same year as rodman on the Cornwall & Lebanon, and in 1884 entered the service of the Pennsylvania as transitman. In 1886 he was draftsman in the assistant engineer's office on the West Penn division at Blairville, Pa., and from date to 1911 he was engaged on various divisions on the same road as assistant engineer, assistant supervisor, supervisor, assistant superintendent, and latterly as general superintendent on the Western Pennsylvania division at Pittsburgh, Pa. In 1917, Mr. O'Donnel was appointed assistant general manager of the Lines East of Pittsburgh, and in July, 1918, was promoted to general manager which position he held, at the time of his recent appointment as vice-president in charge of the Central region of the road. He has thus been thirty-seven years in the service of the Pennsylvania, and has had an extensive experience in the construction and transportation departments.

Foremen Classed as Officers.

Because of the exceptional importance of the work of supervisory foremen in the mechanical departments, and the fact that economical and efficient shop operation depends so largely upon their efforts and co-operation, W. T. Tyler, director of the Division of Operation, has issued a circular letter to the regional directors stating that it is desired that their classification, working conditions and privileges be made definite and uniform.

To that end the Director General directs that general foremen, roundhouse foremen, departmental foremen and assistants will be classified as officers and will be given consideration and advantages attaching to officers of similar rank in other departments, as follows:

a. Reasonable period of time lost on account of sickness without loss of pay.

b. Two days off each month for all salaried foremen whose tour of duty consists of seven days per week.

c. Two weeks' vacation a year with pay for all salaried foremen who have acted as officials continuously for one year or more.

d. Privilege of resigning instead of being shown as discharged or dismissed.

e. When charged with an offense likely to result in dismissal, a hearing to be given by a superior officer other than the immediate superior, at which hearing the foreman in question may be represented or assisted by any other foreman whom he may select for that purpose.

f. Card transportation to be granted to all salaried foremen, the extent of such transportation to be based on the general practice for other division officers and the importance of the position the foreman occupies.

The American Society of Safety Engineers.

The above society has recently been reorganized, with headquarters in the Engineering Societies' Building, 29 West 39th street, New York City. The society was incorporated in 1914, and is now thoroughly established to function nationally in safety engineering as other national engineering societies function in their particular fields. It has become more and more evident that engineering skill must be applied to the reduction of casualties. Careful studies of accident prevention have shown that 65 per cent of the fatalities and major mutilations are preventable by engineering revision. Executive secretary, G. B. Muldaur, Casualty Engineer, 29 West 39th street, New York.

Mechanical Puzzles.

The London *Engineer* brings up a few engineering, unsettled questions that, although not important enough in themselves to call for a commission to report upon, are nevertheless curious. For example, why is a long screwdriver a more effective tool than a short one? It is generally accepted by users of screwdrivers that it is so, but why it should be is not very clear. There is another old and familiar problem which never recurs without generating heat. It is the right position for a lock-nut. We have heard the hardest things in the world said about the engineer who puts the thin nut on top of the thick and *vice versa*.

Traction engineering presents many interesting puzzles, from the belief firmly held by many coachmen that a carriage with a short wheel base and short shafts is easier on the horse than one with the wheels far apart and the horse a long way from the wheels, up to the more serious question why electric traction is harder on the rails than steam traction. We pass over the familiar problem of corrugated rails, and note the curious puzzles presented by the wear of locomotive axle-boxes. Why was it, in certain North-Western engines, always the third coupled axle-box that ran hot, and why is it that the wear of the driven axle-boxes is not always equal, but seems to depend upon which crank leads? Engineering is full of these little problems, and, like petty ailments, they seem to defy the doctors, when more serious ones are put right.

Rickert-Shafer Announcement.

The Rickert-Shafer Co., of Erie, Pa., manufacturing the well-known Boehm automatic die head, and the Rickert-Shafer line of automatic tapping machines are announcing recent appointments in their organization, as follows: A. A. Shafer, secretary and general manager; C. W. Howard, formerly with the General Electric Co., general sales manager; A. J. Patterson, formerly with the Crucible Steel Co., general superintendent; George Paterson, production manager.

This prosperous and fast-growing company feel confident that with this line-up they will be better able to carry forward their well-defined policy of best quality and best service.

Electrification of the Dutch Railways

It is reported from Holland that a commission of Dutch engineers will shortly visit America to study the electrification of railways, with a view to changing the motive power on the Dutch railway systems from steam to electricity.

BULLETINS, CATALOGUES, ETC.

Welding Flexible Staybolts.

The February issue of *Staybolts*, published by the Flannery Bolt Company, Pittsburgh, Pa., contains illustrations and remarks explaining the first application of the company's flexible staybolt to a locomotive boiler, a replacement application by the removal of the Tate sleeves and substituting the "F. B. C." welded sleeves, welded to the outer plate. The entire series of operations is fully described including the approved method of taking out the tate bolts and sleeves. This includes the alignment, if necessary, of old holes, the counterboring for the flush sleeves, which may be done at an average rate of a little over three minutes each, the adjustment of the tool for holding the sleeve, the cleaning of the sheet, and welding, which also may be done in less than four minutes, the reaming and tapping of the fire sheets, the application of the bolts and cutting off and riveting over, and the application of the caps; with additional information in regard to tests, the whole forming a complete code of instructions presented in such a manner that it needs only to be followed intelligently by the average mechanic. Copies of the publication may be had on application.

Pipe Coverings.

A new catalogue has just been published by the Franklin Manufacturing Company, Franklin, Pa. It extends to 77 pages and contains full descriptions of insulating and pipe covering products, magnesia pipe covering, wool felt covering, asbestos millboard, railroad special pipe covering, and the well-known Franklin car lining. A series of tables and engineering data is appended, the whole forming a complete instruction book in regard to pipe and other coverings. The use of the tables is fully explained by examples that are something new in the way of exact calculations necessary in ordering the company's products. Details regarding the best methods of shipping and packing are also added. Copies may be had on application to the company's main office, Franklin, Pa.

Dixon's Silica-Graphite Paint.

The February issue of "Graphite" contains among other interesting matter, a pointed article on the durability of Dixon's Silica-Graphite Paint. It appears that the bridge crossing the Delaware River at Trenton, N. J., was painted with a coating of this preparation in 1914, and it certainly looks as well today as if it had been painted last fall. The summer's heat or winter's snow does not seem to affect it, so it is immaterial what salaries are paid to painters, it will evidently be some time before they are called to the Trenton Bridge. It may cost more than some other paints, but it has the durability of the pigments that glisten on the coffin lid of a galvanized mummy.

U. C. Brake Equipment.

The Westinghouse Air Brake Company has just issued their descriptive catalog unit No. 2021, which succinctly describes their standardized UC brake equipment for steam road passenger trains, and which, with simple electric attachments, comprises the highest development of electric pneumatic train brake for both electric and steam road passenger trains. The pamphlet is well prepared both as to text matter and illustrations.

Common Carriers.

Among the recent pamphlets issued by the Interstate Commerce Commission is an abstract of statistics of common carriers, compiled by the Bureau of Statistics, furnishing a complete list of railroad and other transportation routes in operation up to the end of 1918. Copies are being distributed on application to the Bureau of Statistics, Washington, D. C.

Safety Catalogue.

F. A. Hardy & Company, New York, has issued a handy safety catalogue, giving full details of equipment for first aid in accidents in shops and factories. It extends to 46 pages, and should meet with popular favor.

Transportation Act.

The complete text of the new law embodying the act under which the railroads have been returned to their owners has been issued in booklet form by the Guaranty Trust Company of New York. A summary of the act is also appended for ready reference and also a condensed history of the various acts relating to transportation, beginning with the enactment of the Interstate Commerce Act in 1887 up to the present time. Copies may be had on application to the publishing company.

Railway and Locomotive Engineering
A Practical Journal of Motive Power, Rolling Stock and Appliances
Vol. XXXIII 114 Liberty Street, New York, April, 1920 No. 4

Electric Locomotives for the Chicago, Milwaukee & St. Paul Railroad

Illustrated Description of the Many Improvements in Their Construction and Mechanical Details

In our issue for December, 1919, there was published a description of the electric locomotive built for the Chicago, Milwaukee & St. Paul R.R. by the General Electric Co. at its Erie works. This description touched only on the general features of the design and did not enter into the details to any extent.

It is our privilege here to present some of the mechanical details that will be of special interest to all railroad men.

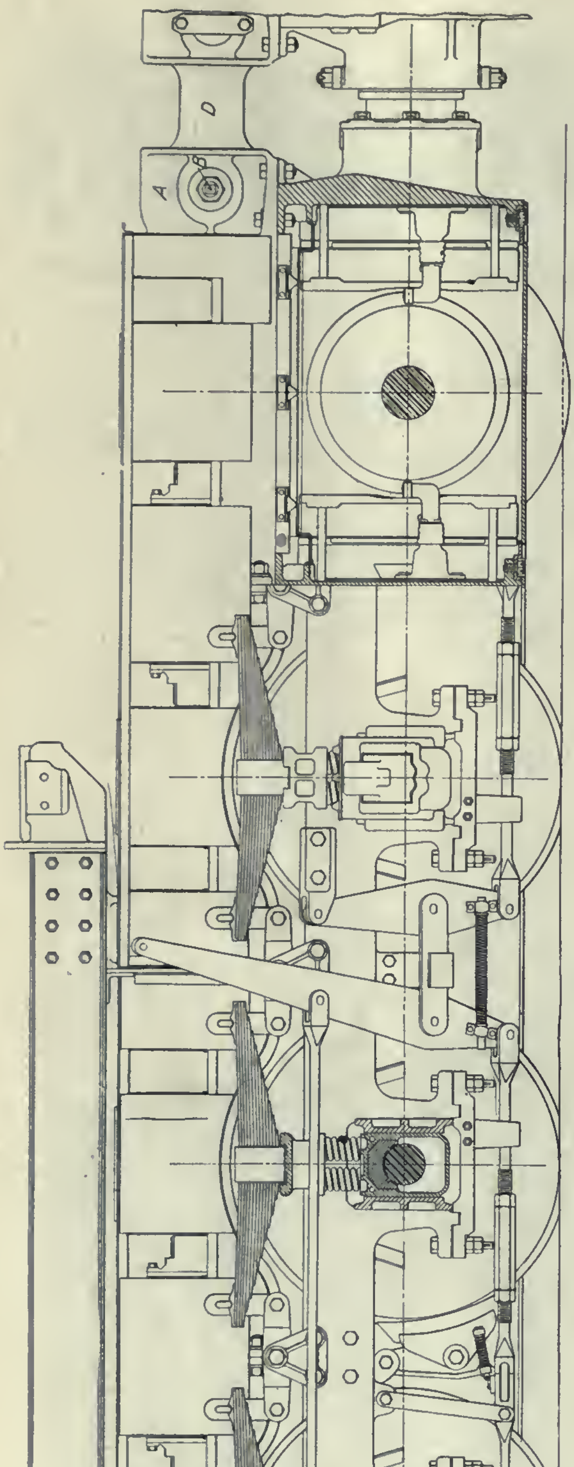
First among such details stands the truck and running gear. There were many problems to be solved in this aside from the mere detail of the distribution of sufficient load to furnish the adhesion required to meet the demands of traction.

The tractive effort required to meet the specifications for operation, having been decided with the choice of the gearless bi-polar motor as means of propulsion, it developed that both of these could best be met by the use of 12 driving axles. Then came the laying out of the wheel bases and the truck arrangements to best meet the service demands put upon it.

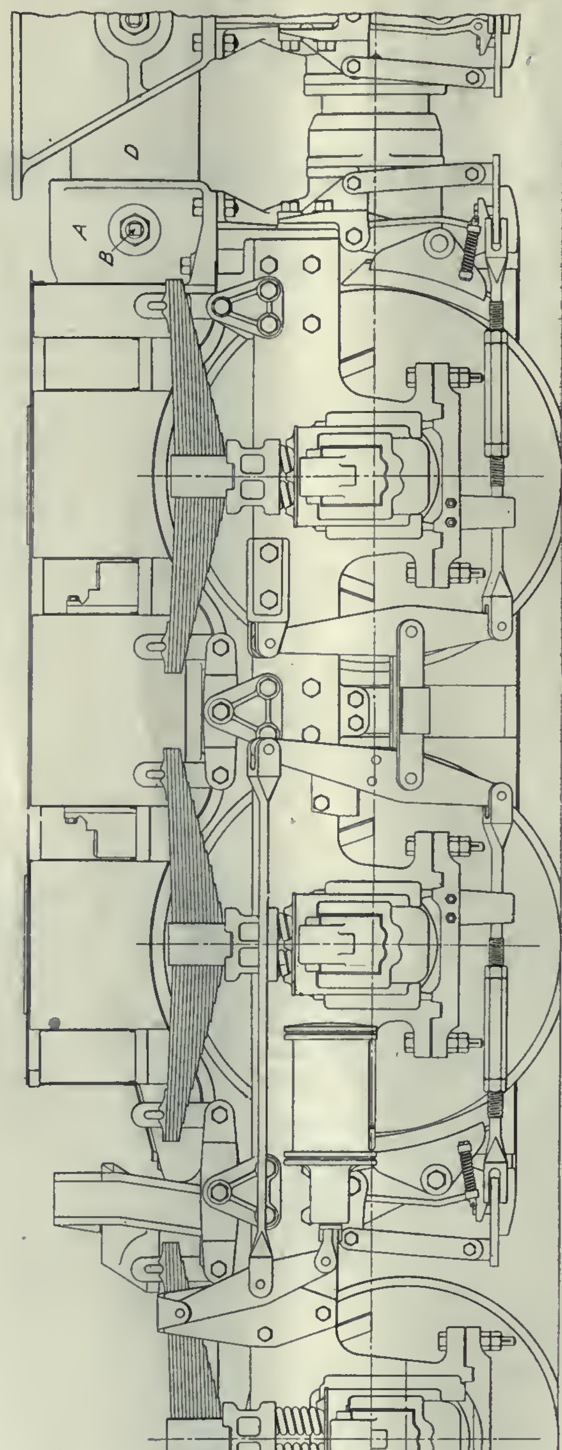
"OLYMPIAN" C. M. & S. P. R. R. CRACK PASSENGER TRAIN EMERGING FROM SNOW SHED ON CASCADE DIVISION.

The final decision was to use two main driving trucks of eight wheels each with a leading truck having six wheels four of which were motor wheels and the other two guide wheels.

The use of a guide wheel held in the



EIGHT WHEELED MAIN MOTOR TRUCK.

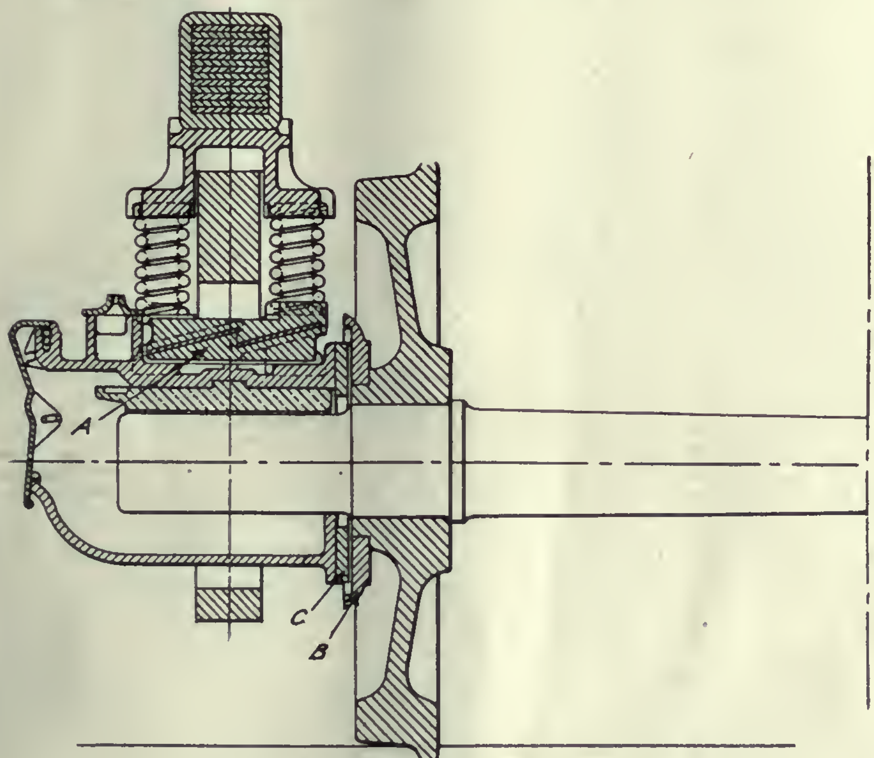


SIX WHEELED END OR GUIDING TRUCK.

Motor Trucks of C, M. & St. P. Electric Locomotives.

same frame as the wheels it is to guide is a new arrangement and one which, as far as we are informed has not been in use heretofore.

In this case the mechanical arrangement is such that the wheel is a true guiding wheel and not merely a leading wheel of a truck. The drawing of the section of the guiding wheel journal box shows the very simple means by which this is accomplished.



AXLE BOX FOR GUIDING WHEEL OF END TRUCK.

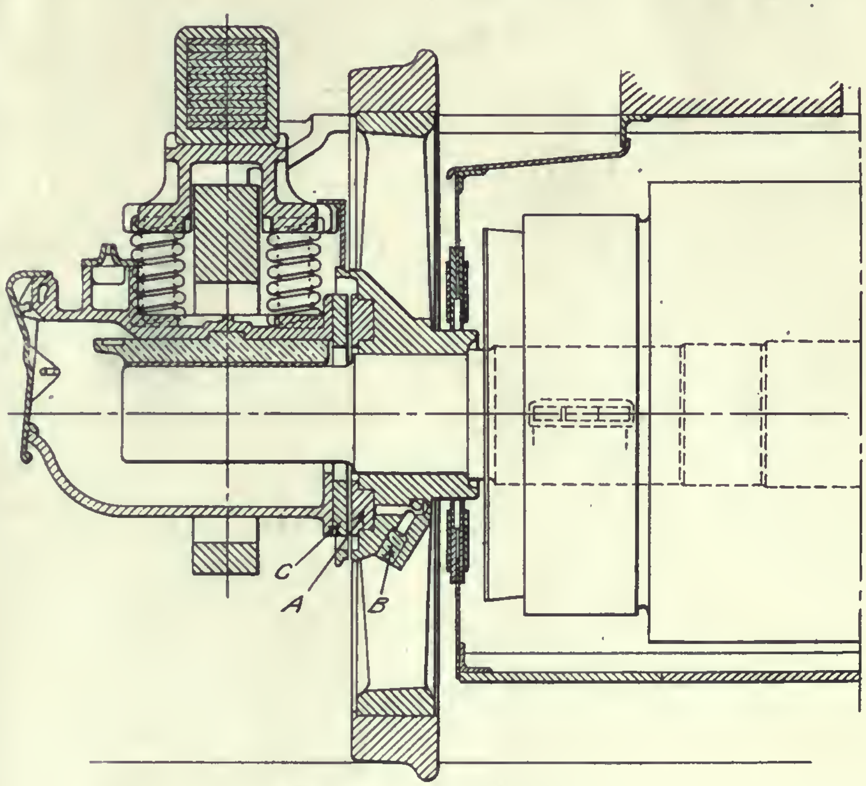
Before taking up the reason for this it will be well to consider the method of carrying the end cabs and the influence of this on the action of the end trucks. These cabs are rigidly attached to the main truck frame and move with it. The outer end of the cab overhangs its frame and the weight of this overhang is carried on the leading truck at a point between the guiding axle and the leading motor axle, the details of which support will be discussed later. It will be seen from this that the outer end of the cab must swing laterally over the leading truck frame in very much the same way that the front end of the boiler of a Mallet locomotive swings to and fro across the leading frame.

Now to return to the leading truck details. The journal box is fitted to take a collarless journal 6 in. in diameter and 13 in. long. On the top of the journal box there is a saw-tooth wedge block A to which it is rigidly attached. This carries the spring seat, which is a mating wedge block, which is rigidly attached to the frame. It will be seen that this arrangement permits the frame to slip inwardly with reference to the journal box by sliding up the incline of the wedges. At the same time the journal box and frame are free to slip outwardly over the journal because of the lack of collar on the journal.

Now suppose the engine enters a curve. The thrust against the outer rail of the curve tends to move the wheel and axle inward on the outside of the curve and outward on the inside, with reference to the cab and other wheels of the truck because they are still in alinement with the approach tangent. So the axle slips inwardly on the outside of the curve and pushes the oil box and bottom wedge outwardly on the inside of the curve. In the latter the two wedge blocks slip over each other and the truck frame and cab are not only raised but it is done with a cushioning effect that softens the blow that would otherwise be delivered to the cab to deflect it from its tangential course. As the weight causes the upper wedge block to slide down over the lower one, the truck is turned from the line of the tangent to follow the curve. This lateral motion is necessarily limited and amounts to ⅝ in. in all. Of this ½ in. is taken up by the slip of the wedge blocks and ⅛ in. by the clearance play between the wheel hub and the journal box.

In this guiding truck wheel there is a wearing plate B attached to the wheel with another loose plate C to protect the box.

None of the motor axle journal boxes have the wedge blocks but have the arrangement shown in the sectional engravings of the same. The difference between the two lies not only in the absence of the wedge blocks but in the arrangement of the wearing plates on the wheel and journal box. One of the features of this is the use of the Smith hub plate A which was specified by the railroad company. This hub plate is let into an annular groove in the hub of the wheel and is



MOTOR AXLE JOURNAL BOX.

pressed in under a pressure of about 40 tons. In addition to this a leather packing is laid against the inner surface. Back of this grease is forced by a pump screwed into the socket B. When this hub plate wears it is forced out the amount required to take up that wear, by a pump attached at B. The hole is then plugged. This merely amounts to jacking out the plate and preventing it from being forced back, by the lateral blows of the truck, by the grease that is locked in behind it.

In addition to this there is a protective wearing plate C which is prevented from turning by lugs entering the back of the journal box but which is free to move in a line parallel to the truck axle. These wearing plates are arranged to permit a total lateral movement of ⅛ in. when new, but will be readjusted when the total wear amounts to ½ in. but this will, however, depend on the railway maintenance.

In this connection attention is called to one of the features of the machine which will be alluded to later and that is the attempt made to have all parts so accessible that repairs are easily and readily effected. In this particular instance we have that of the renewal of these wearing plates. To do this the pedestal tie bar is removed and the U-shaped wearing strips on the pedestal legs are dropped down and removed. As the thickness of these wearing strips is greater than that of the lugs on the journal boxes, their removal makes it possible to slip the journal box out between the pedestal legs and off from the axle.

Then, while the outside diameter of the hub wearing strip is greater than the distance between the pedestal legs, the hole through it is so large that it can be canted and easily pulled off over the journal.

There is another detail connected with this easement of the curving action that has an important influence on the truck action. It is the method of supporting the cab on the front truck. As already stated allowance must be made in this support for the lateral displacement of the truck under the end overhang of the cab. This support consists of two inclines one on either side of the truck upon which two rollers, attached to the cab frame, ordinarily bear. The inclines have the form shown in the engraving. Under ordinary normal conditions of the engine on a straight track each roller has a bearing on its respective incline and the weight supported is evenly distributed on each side of the center.

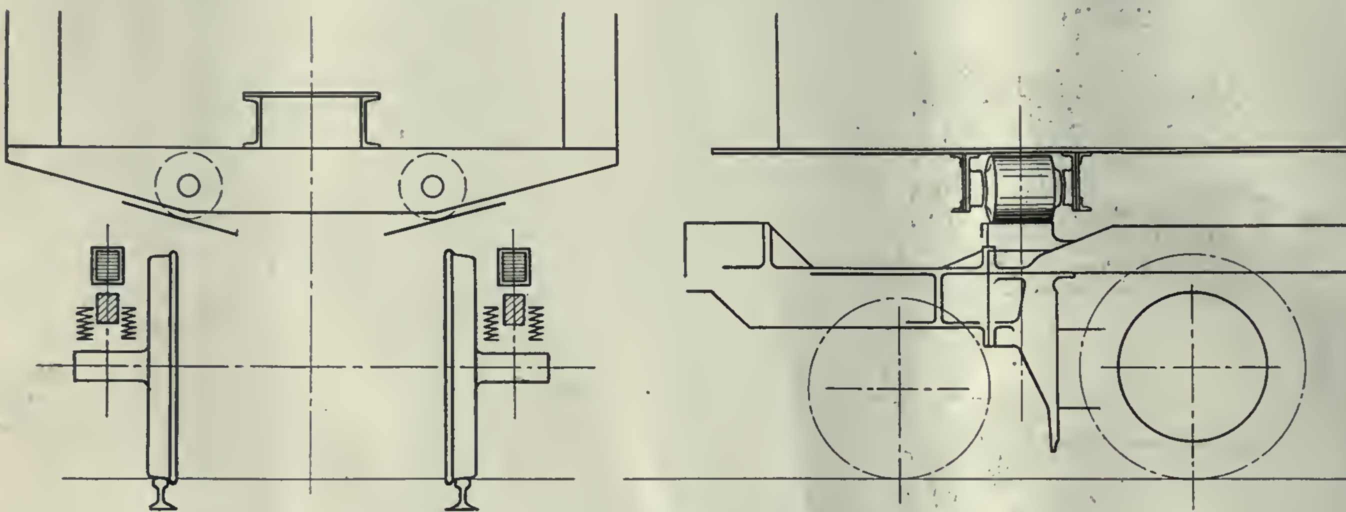
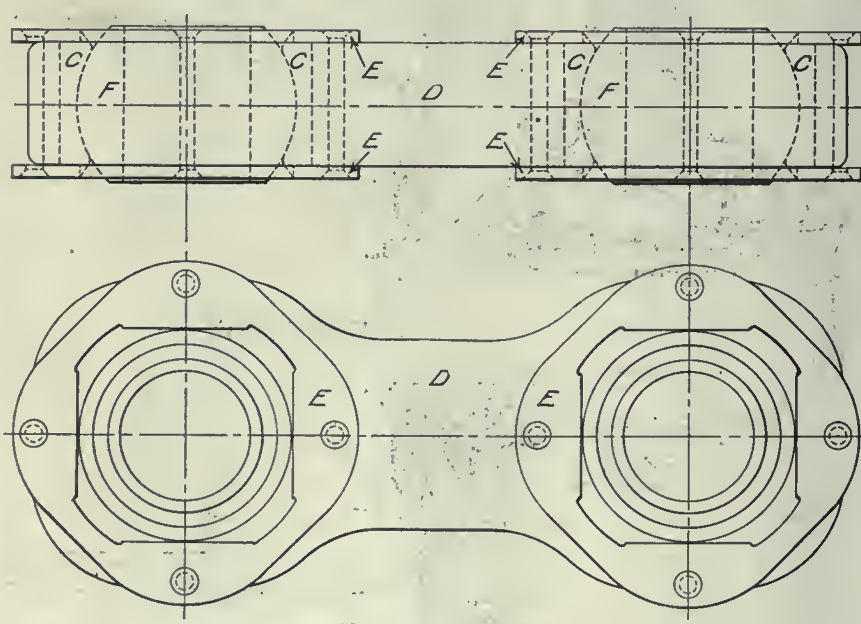
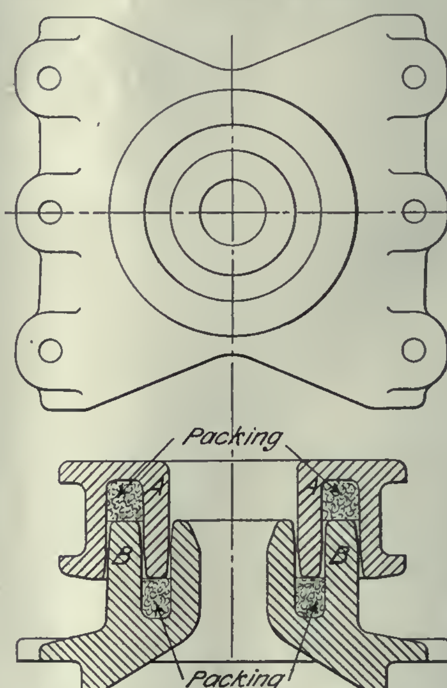


DIAGRAM OF METHOD OF CAB SUPPORT ON END TRUCKS.



BALL JOINT DRAWBAR.



ARTICULATED COUPLING BETWEEN TRUCKS.

When the truck shifts laterally the roller on the inside of the curve leaves its incline while the one on the outside rolls up thus transferring the load from the two to the one on the outside. This depresses the spring on that side and, at the same time, lifts the cab to a slight extent. This lifting also throws an additional load on the front truck and assists in holding the guiding wheels down on the rails.

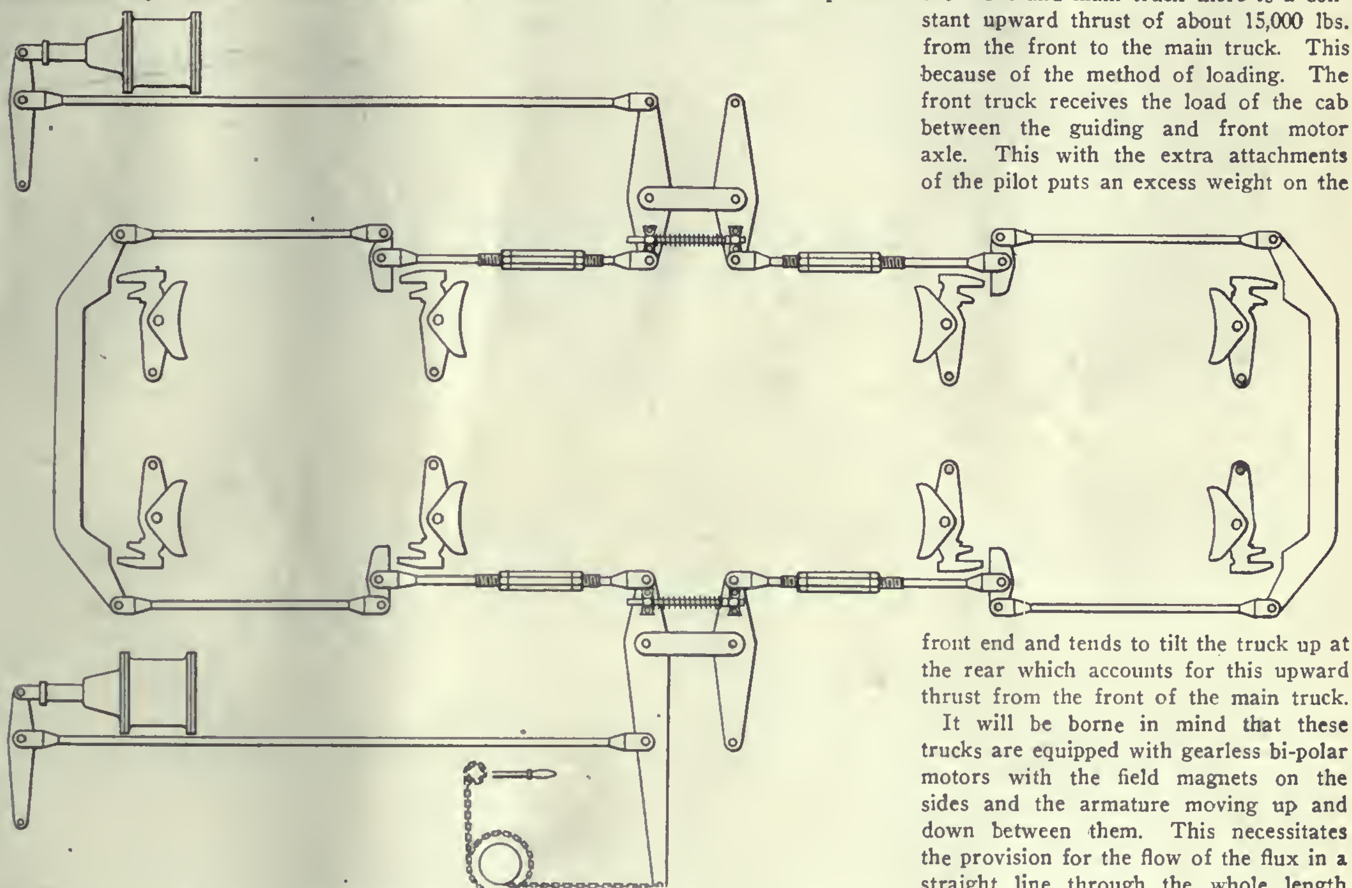
During the whole period that this condition prevails there is a constant tendency of the roller to move down its incline towards its own normal position and thus carry the end of the cab with it, thus using it as a sort of tongue to guide the cab and with it the main truck about the curve.

This shifting of the supporting point of the cab from the two sides to one throws a twisting stress upon the cab frame which must be met by a rigid construction.

The center sills which form the main line of support of the cab are formed into a regular box girder with top and bottom cover plates. As this would not be strong enough to resist the torsional stress already alluded to, the whole frame is stiffened by a strong steel casting in the form of spacers. This is rivetted between the channels forming the girder and has ribs uniting its two sides at frequent intervals so that the sill can sustain the whole cab when supported at the front on one side only.

The connection between adjacent trucks is made in two ways. At the top there is a link connection shown in the engravings. This is a connection by which a thrust or pull can be communicated from one truck to the other. The link by which the two trucks are connected has a ball and socket joint at each end, and the section is much larger than the mechanical work put upon it would require, the additional metal being put in, as in the frames, to carry the flux. The ball and socket ends of the draw-bar are built up of a number of pieces. There is a casting A bolted to the truck through which a pin B is passed. This pin also passes through a ball F fastening the latter rigidly in position and thus forming the ball. The ball is clasped by the two halves of the socket C which is slipped into the draw-bar D and moves with it. The socket is then held in place by the two washers EE the holes through which are large enough to permit of the necessary movement of the draw bar relatively to the pin. In assembling the parts the socket is first put about the ball. The two are then slipped into place in the opening in the draw-bar and fastened by the washers. The whole is then dropped into place, the pin put through and fastened.

In addition to this link connection there is another serving both mechanical and electrical requirements. It consists of an articulated joint as shown in the engraving. This joint consists of a series of rings A and B that set into corresponding pockets in a casting in the adjoining truck. It will be noticed that the projecting rings are slightly beveled so that, although they may be in contact with the edges of the corresponding depressions in its mate, there is still a possibility for each to assume an angular position with reference to the other according to the motion of the two trucks. In the case of the connection between the front and main truck there is a constant upward thrust of about 15,000 lbs. from the front to the main truck. This because of the method of loading. The front truck receives the load of the cab between the guiding and front motor axle. This with the extra attachments of the pilot puts an excess weight on the front end and tends to tilt the truck up at the rear which accounts for this upward thrust from the front of the main truck.



FOUNDATION BRAKE RIGGING FOR MAIN EIGHT WHEELED MOTOR TRUCK.

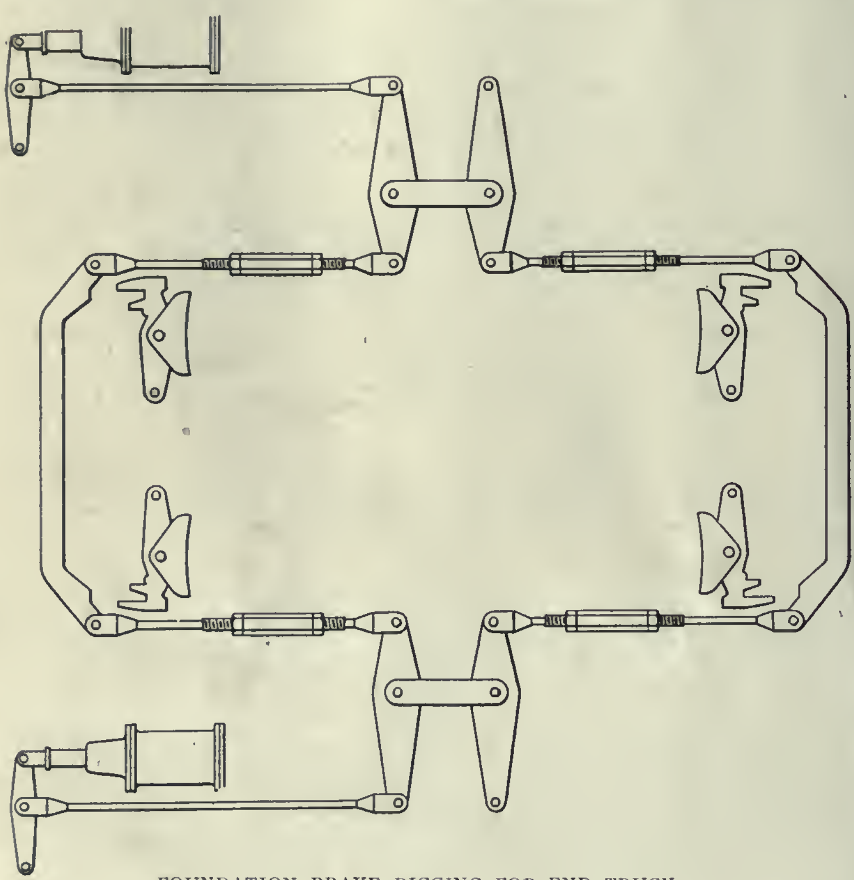
It will be borne in mind that these trucks are equipped with gearless bi-polar motors with the field magnets on the sides and the armature moving up and down between them. This necessitates the provision for the flow of the flux in a straight line through the whole length of the engine on the center line of these magnets and a return through the body of the frame. These articulated connections serve the purpose on the center line and the truck frame for the return. It is for this that the truck frames are made so heavy. They are much stronger and heavier than the mechanical necessities demand, but have to be made of these large dimensions in order to carry the flux. In short, the truck is two or three times as heavy as would be required for the carrying of the load and sustaining the running stresses alone.

This discussion of the running gear of the end truck applies to the main trucks as well.

Here again we have an example of the ease with which repairs can be made in the removal of wheels. A wheel drop is all that is necessary. The removal of the pedestal tie bar leaves axles, wheels and armatures free to be dropped from the locomotive and removed.

The frame is made so strong and heavy in order to provide for the flux currents so that no ties between pedestals are required.

front section of the cab is occupied by the necessary resistance coils and is closed while the engine is in operation because of the high voltage of 3,000 prevailing therein and the danger to life should a man be thrown, by the movement of the engine against any of these parts. The central passage, however, is of ample width to accommodate a man to make repairs when not in service. In addition to access from the interior equal facilities are afforded for outside accessibility for removal of parts for repairs through the side openings in the cab.



FOUNDATION BRAKE RIGGING FOR END TRUCK.

There is but one point more on the trucks to which attention need be called and that is the brake arrangement. Although the regenerating features of the electrical apparatus are quite sufficient to handle the trains and regulate the speeds on grades, there is a full air brake equipment for stopping.

The foundation brake rigging on the engine is arranged with two brake cylinders on each truck. The levers and connections are all outside the wheels so that repairs and renewals can be readily made. The rigging is interfulcrumed and the end brakes are tied together across the machine to hold the brakeshoe in place. This does not involve any real cross interfulcruming as the lever arm on the brakebeam is too short to have any appreciable effect on the opposite side. The general arrangement is clearly shown on the engraving of the side elevation of the truck as well as in the diagrams of the brake rigging.

The cab arrangements are such that the engineer has ample room for convenience in working and from his seat has a clear view of the rails ahead of him. The

The cab itself is provided at its four corners with heavy lifting lugs by which it can be lifted clear of its supports on the trucks in case of necessity. The general appearance and location of the lugs is clearly shown by the reproduction of the side elevation. They can be used not only to lift the cab from its seat in the shop, but are strong enough to hitch to to lift the engine in case of derailment and put it safely back upon the track.

As the engines run through a cold climate at all seasons of the year it has been necessary to use double panes of glass in all windows used for visual work. The method of building up the sash is shown in the accompanying engraving. It will be seen that all of the woodwork is sheathed so that there will be no flying splinters in case the sash and windows are broken. Wired glass is used in all windows that are not for visual work.

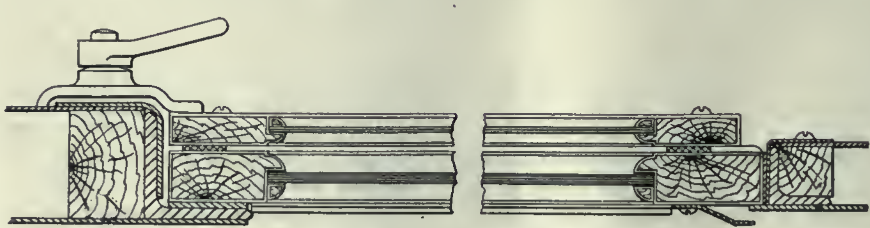
The protection of the motors from dust is accomplished by means of a shield, and the cooling by a draught of air driven by a fan and circulating from the inside to the out.

The central cab, which contains the heating boiler as described in the previous article, is so designed that it can be lifted clear of the frames, for its own overhauling or that of the boiler or the boiler can be lifted out through a hatch in the roof. This cab is carried on the two others. There are heavy lugs rivetted to the cab ends on which the central cab rests on a center plate so that it can assume an angle with the cab end. Relatively to one cab the central cab always occupies a fixed position longitudinally, whereas it rests on a sliding plate at the other so that there is a chance for compensation for any variations in the longitudinal distance between the two.

The heating boiler is a large one, capable of evaporating 4,000 lbs. of water per hour and is probably of greater capacity than will be required for the heating of any passenger train that the engine will be required to haul, but it was placed there on the specification of the railroad company. It is of the vertical fire tube type, is 72 in. in diameter and contains 546 tubes 1½ in. in diameter and 38 in. long. It is fired by oil and sets on top of a brick fire-box, having a height of 29 in. from the floor to the bottom tubesheet. It has a total heating surface of 756,48 sq. ft. made up as follows:

Tubes	678.00 sq. ft.
Firebox	34.10 " "
Cove	9.83 " "
Tubesheets	34.55 " "
	756.48

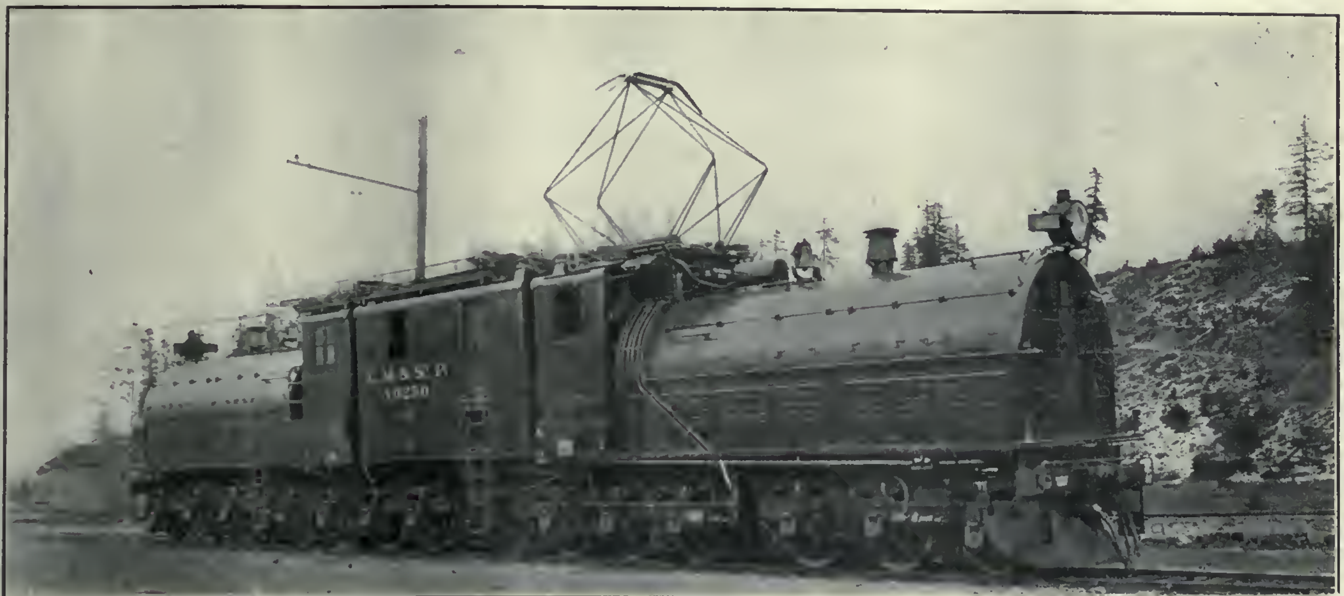
The grate area is 23.2 sq. ft. making a ratio of 32.6 to 1 between the heat-



DETAILED SECTION OF SHEATHED WINDOW SASH.

ing surface and the grate area. The water tanks form a portion of the sides of the cab, while the oil tanks are placed beneath the floor. There is a free communication through the central cab from one end cab to the other.

On the tests that have been made of the engines their remarkable ease of motion has been the subject of a great deal of favorable comment. At sixty miles an hour on the experimental track at Erie, the riding is as smooth and even as any parlor or sleeping car and much better than many day coaches. The reason for this is not entirely clear and any analysis must be more or less academic at present until further experiments are made.



ELECTRIC LOCOMOTIVE BUILT BY THE GENERAL ELECTRIC COMPANY FOR C. M. & ST. P. R. R.

Electrification of the Great Eastern Railway of England.

At the annual meeting of the Great Eastern railway of England held last month, the deputy chairman said that the Board had instructed the general manager, acting in consultation with other experts, to prepare a scheme of electrification. Sir Henry Thornton, who was devoting much attention to the subject, was of opinion that the suburban zone served by the Great Eastern Railway lent itself more readily to electrification than that in most other suburban areas, because they had a great density of traffic, a number of traffic routes all diverging from one terminus, and an immediate and pressing demand for increased passenger facilities. Investigations had not yet proceeded far enough to permit predictions as to the financial results to the company, but it was hoped that electrification would procure material economies coupled with a large stimulation of traffic.

Motive Power in Russia.

It appears from the latest reports that the policy of M. Wuchlor, the Russian railway minister, has seriously affected the means of repairing the rolling stock. He has refused all credits to keep up the equipment and the renewal of the machinery in the repair shops, and stopped the plan for erecting large modern shops for the repair of locomotives on a large scale. In 1914 Russia had less than 20,000 locomotives on a railway system of more than 64,000 versts (42,240 miles). Of these 7 per cent. were more than forty years old, 10 per cent. more than thirty years, 6 per cent. more than twenty years, 39 per cent. more than ten years, and only 38 per cent. under ten years.

Before the war the average life of a locomotive in Russia was twenty-five years—twice as long as in America—but during the war Russia was obliged to adopt the American system of the intensive use of locomotives. Competent railroad experts considered that of all the locomotives constructed before 1914 only a few—probably less than 100—were left intact. Therefore only those locomotives built or imported since 1914 are to be taken into consideration at present. Of such there are only 3,765, including 3,000 built in Russia in the last six years and 765 imported in 1916 and 1917. This, in round figures, provides 4,000 locomotives for about 50,000 versts (33,000 miles) of railway, or eight locomotives for each 100 versts (sixty-six miles).

The transport crisis is very grave and will remain so until Russia gets more new locomotives. It looks as if that country is entirely dependent upon the little that Europe can do, and what America can do fully and effectually if the cost is forthcoming.

Automatic Appliances.

The gradually increasing burdens that have been placed upon the shoulders of the engine-driver—until today it may be said he carries practically the whole load so far as the safety of his train is concerned—have made the weight of his responsibility more than one man should be asked to carry if the safety of the train movement is to be given the consideration it should.

That relief is coming in the form of automatic acting machinery. There was a time within the memory of many of us when the only thing automatic about the locomotive was the safety valve to relieve boiler pressure, but to-day we have the automatic coupler, automatic drifting valve, injectors that are automatic to the extent of varying the water supply to suit varying steam pressure, automatic control of air pump by governor, automatic super-heater damper, semi-automatic lubricator to feed oil to valves and cylinders, semi-automatic sander and bell-ringer.

The automatic stoker is also past the experimental stage, and it is not too much to hope that in a few years it will come into general use, thus insuring the engine-driver the aid of the fireman as a look-out as well as a more uniform steam pressure that can be had with average hand firing, and even the oiling of the machinery, aside from the cylinders, may now be done automatically. The importance of this latter feature is not fully appreciated, but the general spirit of satisfaction among the engineers and others at the introduction of labor saving devices is noticeable.

Thermit, Electric and Oxy-Acetylene Welding

Opinions as to the Best Methods and Materials by Experienced Experts

At a recent meeting of the Canadian Railway Club held in Montreal, W. N. Ludington stated in the course of an address on autogenous welding that electric welding was suitable for steel and iron only, and that it was not possible to weld cast iron by the electric welding process, except in certain freak cast iron jobs. The advantage of electric welding over oxy-acetylene in steel and iron is owing to the fact that the largest portion of the work, resulting from wear on boilers or tanks which occurs in the seams or those parts that have riveted construction. As the electric welding heat is so concentrated, it is possible to place a weld close to rivets without disturbing the rivets in any way; in fact, a heavy weld can be built up on a seam without the plate becoming red hot. To do this by Oxy-Acetylene would mean a large area of the plate would become white-hot, a smaller area red hot, and we would have the rivet shanks heated up, the diameter of the rivet holes would become smaller owing to expansion, the rivet shanks would be squeezed out of the holes, and it would be impossible to permanently make these rivets tight without replacing them. The electric welding, therefore, has an enormous advantage over oxy-acetylene on this class of work. It also has a field in building up steel shafting that has become worn in the bearings. The method used is to add sufficient metal so that the shaft can be turned down to full size of the original bearing.

Generally speaking, oxy-acetylene welding has been found by the metal trade more adaptable than the electric welding for the heavier work, also where the physical properties of the weld is an important factor. While the oxy-acetylene flame has a temperature of 6,300 Fahr., and the electric arc is nearer 9,000 Fahr., in practice the same volume of heat is not available; therefore the oxy-acetylene process with its lower temperature is capable of developing sufficient heat to melt a large mass of metal and keep the same in a plastic state while being worked with comparatively no danger of burning the metal.

It would be difficult to define the field which the metal trades have found thermit, electric and oxy-acetylene welding best suited for, but A. M. Barry, managing director of the St. Lawrence Welding Company, which uses all three processes in the course of their work and use the process best suited for the job they have on hand, stated that thermit welding is used principally for large welds in steel or cast iron. There is practically no limit to welds that can be made by the thermit process, and the very heavy sections of rolling mill equipment, heavy frames, cylinders and large panels can be successfully welded by the thermit process. The reason for this principally is that the weld is made more or less automatically. It is cast instantaneously, in fact the reaction occurs in thirty-five seconds, and after the weld is poured we have a high grade chrome nickel steel weld of great tensile strength.

In cutting with the oxy-acetylene torch, the principle of which is to heat the metal with the oxy-acetylene flame to a red heat, then by turning on a jet of pure oxygen, which burns away the metal. The cutting is undoubtedly a process of combustion. The cutting with the oxy-acetylene torch at present is practically limited to wrought iron, the different grades of steel, some of which cut easier than others, varying with the carbon contents and nature in which the carbon is found in the steel. The dropping of temperature, due to the forming of a slag on the surface of the kerf cut confines the combustion as desired, and the kerf cut is practically confined to the course of the jet of oxygen.

All the welding torches in use today can roughly be classed under two headings, the injector type and the medium pressure type. In the case of the injector type, the acetylene is fed to the torch at very low pressure, ranging from one to six ounces. In the medium pressure torch the acetylene is fed to the torch at a pressure of from one to six pounds. The actual pressures in each case depend upon the size of tip, which in turn depends upon the thickness of metal to be welded.

A statement was made by L. Brown that he recently had occasion to get some tests made of oxy-acteylene and electric welding on quarter inch rolled steel sections and the result of the tests showed that while the electric welded points were stiffer and stronger than the original section, the oxy-acetylene welds failed.

Mr. Barry stated that most failures in the lighter sections are the results of unskilled operators. The welding rods have to be carefully selected. Electric welding is not as strong as the oxy-acetylene process for brackets, or shafting. The failure would show that the oxy-acetylene welder was not using proper welding rods. We have had tests made showing that the oxy-acetylene weld is at least 98 per cent the strength of the original bar up to one inch in diameter. If we get a new operator and wish to put him on important work, we give him some bars and watch how he welds them. Then they are tested, and as a result of this test we are able to tell whether he is a skilled operator or not and whether he knows how to select the material he is going to add. If we get over 3½ in. sections in steel it is then time to use thermit. However, the dividing line between the three processes is more or less indefinite, and it is up to the skill of the men handling it and the kind of work that they do.

Regarding experience in welding, Mr. Payne stated that he had seen a lot of welding work done both with the oxy-acetylene and the electric, and there was always an excuse when the weld does not turn out well. Either you have not used a skilled operator or you have not used the proper quality of iron to make the weld with.

Mr. Barry stated that schools and institutions were turning out welders after a dozen lessons or so, whereas in France they take young boys from 16 to 18 years of age and send them to a technical school where they are taught all about oxygen and acetylene. These boys are given a mechanical training and they give them a highly technical training as well. When they come out of this school they know the theory of it down to perfection and they are then apprenticed to a first class welding works for a period of four years; in other words, the French government claim that these oxy-acetylene welders are entitled to a first-class welder's certificate which enables them to do any kind of oxy-acetylene welding. These boys have to put in eight years learning the trade.

In England there are similar schools run by the Government and there is the British Welding Association, which is working along the same lines. The term of apprenticeship is as long as it is France. Today in Canada a boy goes up to the technical school and gets eight or ten lessons and he is then a first class welder. He goes into the welding shop and makes a lot of noise, but when he comes to do the work he gets a black eye. The result is that all large welding works train their own men. The Soldiers' Civil Re-establishment are undertaking to teach the men to become welders in eight months, and while they get along fairly well, it is impossible to learn this trade in that time, although they may be able to handle certain repetition work very nicely.

As to the work the line between the three processes is more or less indefinite, and it is up to the skill of the men handling it and the kind of work they do. Electric welding is not usually considered as strong as oxy-acetylene welding and is not as strong as Thermit welding.

American Design of Consolidation Type Locomotive

for the Belgian State Railways

On March 1 the American Locomotive Company at its Schenectady works, completed the first engine of the order recently placed by the Belgian State Railways. Considering that the design was entirely new, and also that the metric system was used throughout, it is interesting to trace the expeditious manner in which this order for locomotives was handled.

On November 25, 1919, Mr. C. M. Muchnic, Vice-President of the American Locomotive Sales Corporation, sailed for Belgium, arriving in Brussels on December 4th. On December 13th, Mr. Muchnic signed the contract in Brussels for 150 locomotives—75 to be built by the American Locomotive Company and 75 by the Baldwin Locomotive Works. Leaving Havre on December 16th, Mr. Muchnic delivered on December 24th, to the Engineering Department of the American Locomotive Company the necessary information to enable it to proceed with the design of the locomotive. As noted before, the design was entirely new, metric system used throughout, yet in 52 working days the first locomotive was completed.

While the locomotives are American design throughout in all their details, as will be noted from the photograph, the Belgian type of cab and tender were used. This was done in order to permit the American locomotives to couple with the existing Belgian tenders and vice versa. The Railway Company's standard train connection—screw link type with two spring buffers, international system of threads, and French-Westinghouse brake equipment with French-Westinghouse pipe threads were also included.

These engines are to be used in both freight and passenger service and are designed for 16° curves and a maximum grade of 3.3 per cent. Following European practice all the engines are built for left hand drive. All gages are graduated in kilograms per square centimeter.

The specification called for a weight on drivers of 164,000 lb., weight on truck of 22,000 lb., total weight of engine 186,000 lb., and a weight limit per axle of 42,900 lb. The official scale weights are as follows:

First driver	41,600 lb.
Second driver	41,600 "
Third driver	41,900 "
Fourth driver	41,900 "
Total drivers	167,000 "
Truck	21,000 "
Total engine	188,000 "

The boiler is of the straight top type, 68 in. in diameter at the front end, 200 lb. pressure, and has a copper firebox 96 in. x 60¼ in. All staybolts are of copper with a tell tale hole drilled in both ends. The firebox is supported at the front end by a sliding shoe with brass wearing plate and a large oil groove. The jacket is supported on a crinoline frame and is extended to the front end of the smoke box. A brick arch supported on tubes, and a Locomotive Superheater Company's Type "A" superheater are also included. The finished boiler was tested with cold water to a pressure of 19 kg. per sq. cm. but no steam test was required.

Revolving parts were completely balanced in each wheel. The counterbalance for the reciprocating parts was divided among the eight coupled wheels and had to be such that the dynamic augment shall not exceed 15 per cent of the static weight on the rail at 60 k.m. per hour.

All of the side rods have adjustable bearings which is in accordance with European practice.

The by-pass valves are operated from the superheater damper cylinder.

The tender frame is made of steel plate and is supported on three pairs of wheels held in rigid pedestals. The tank is arranged so as to drop down in between the frame.

All material is to the A. S. T. M. standard specification.

The last five of the engines to be built by the American Locomotive Company are to include a Worthington feed water heater.

The American Locomotive Company guarantees all parts of the locomotives for a period of one year, counting from the date of their acceptance. Any part that should fail in service within such period shall be replaced at the American Locomotive Company's expense except when it can be proven that the failure is not due to either defective workmanship or material.

The contract calls for delivery in New York of a total of 50 locomotives (25 from each company) during the month of March and 50 per month thereafter. Due to the severe winter weather and consequent delays in the delivery of materials there will be a slight delay in the delivery of the first fifty locomotives, but the entire 150 locomotives will be completed in accordance with the contract.

The locomotives will be transported to Antwerp by the Red Star Line, a subsidiary of the International Mercantile Marine Company.

The following are the general dimensions of these locomotives, the dimension in millimeters and weight in kilograms:

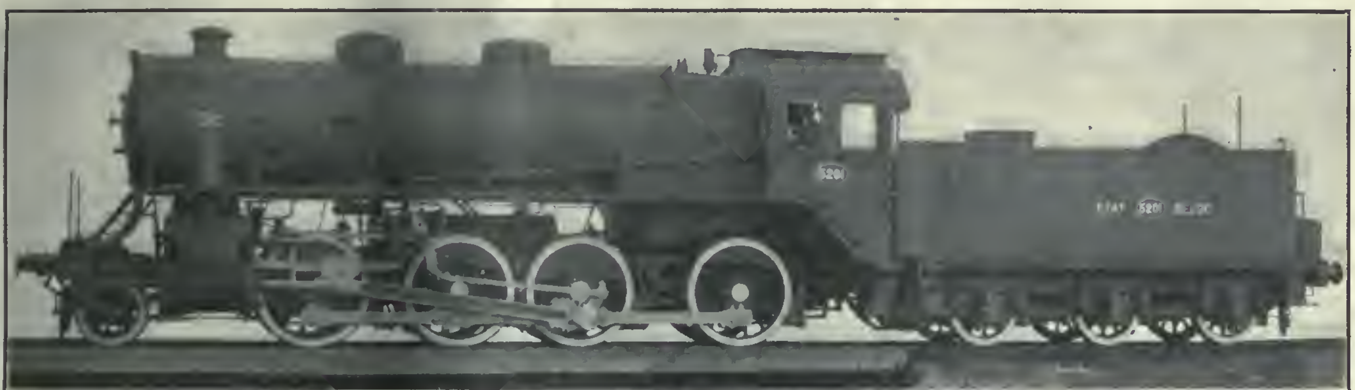
Track.—Gauge, 1435; fuel, bit. coal.

Cylinder.—Type, piston; diam. 61 mm.; stroke, 711 mm.

Tractive Power.—simple valve, 15,800 at 65% compound.

Factor of adhesion, 4.79 compound.

Wheel Base.—Driving, 5941; rigid, 5941; total, 8,352; total engine and tender, 16,344.



2-8-0 TYPE OF LOCOMOTIVE FOR THE BELGIAN STATE RAILWAYS.
American Locomotive Company, Builders.

Weight.—In working order, 85,276; on drivers, 75,750; on engine truck, 9,526; engine and tender, 138,619 lbs.

Boiler.—Type, straight top; I. D. first ring, 1694; working pressure, 14 kg.

Firebox.—Type, wide; length, 2438; width, 1530; thickness of crown, 16; tube, 27/16; sides, 16; back, 16; water space front, 102; sides, 89; back, 89; depth (top of grade to center of lowest tube), 743.

Crown staying, 24 Radial.

Tubes.—Material, seamless steel; Number, 160; diameter, 51.

Flues.—Material, seamless steel.

Thickness.—Tubes, No. 12, B. W. G.; flues, No. 9 B. W. G.

Tubes.—Length, 4724; spacing, 68.

Heating Surface.—Tubes, 119.5 sq. meters; flues, 52.2 sq. meters; firebox, 14.1 sq. meters; arch tubes, 1.6 sq. meters; total, 187.4 sq. meters.

Superheater Surface, 45.0 sq. meters.

Grate Area, 3.7 sq. meters.

Wheels.—Driv. d'a. outside tire, 1520; center diam., 1368; material, main, cast steel; others, cast steel; engine truck, diam. 900; kind, cast steel; tender truck, diam, 1067; kind, cast steel.

Axles.—Driv. journals main, 267 x 254; other, 229 x 254; engine truck journals, 153 x 305; tender, 150 x 260.

Boxes.—Driving, main cast steel; others, cast steel.

Brake.—Operating Westinghouse (French); drive, American; truck, Westinghouse (French); trailer, American; tender, Westinghouse (French); air signal, American; pump 1-type F.; reservoir, 1-775 x 2134.

Engine Truck.—Swing Center.

Exhaust Pipe.—Single nozzles, 135, 138, 141.

Grate style.—Rocking.

Piston.—Rod diam. 102; piston packing, snap ring.

Smoke stack.—Diam., 381; top above rail, 4260.

Tender Frame.—Steel plate.

Tank.—Style, water bottom; capacity, 24,000 liters; fuel, 7,000 kgs.

Valves.—Type, 305 piston; travel, 165 outside lap 27; clearance 3; lead in full gear, 4-5/10.

Calculating Wind Resistance

For many years spasmodic efforts have been made to reduce the wind resistances of locomotives and cars. About twenty-five years ago Mr. Drummond of the Southwestern Railway of England put conical projections upon some of his smoke-box doors, and this was followed on the Paris, Lyons & Mediterranean by the use of wedge-shaped fronts for boiler fronts, stacks, domes and cabs. In this country there was the Adams arrangement, which included the whole train. But none of these arrangements gave satisfactory results after many repeated experiments.

In a recent issue of the *Engineer*, London, Mr. C. F. Dendy Marshall discusses the subject at some length, and states that, thanks to the work which has been done in connection with aeronautics, it is now possible to take the matter up and study it on a scientific basis, with a promise of substantial improvement.

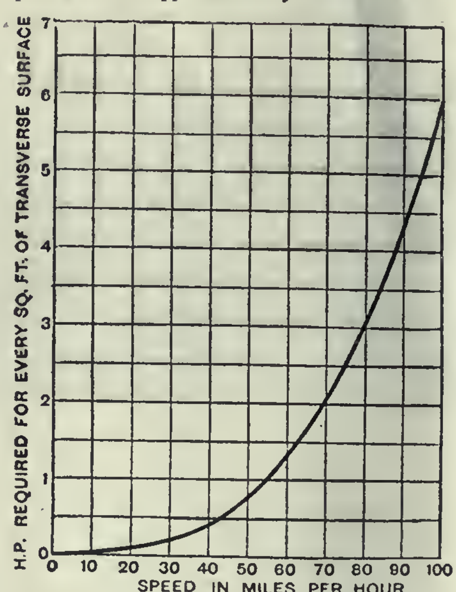
The importance of the front wind pressure on the engine is not fully appreciated. The horsepower required to overcome it increases with the cube, not merely of the speed of the train, but with that of what is called the "created wind," which in the case of an express train may easily exceed eighty miles per hour.

It may now be taken as established that, for speeds within and even far beyond the range of railway speeds, the resistance of the air to a surface moving normally to itself is represented by the expression KAV^2, where A is the area exposed, V the speed, and K a constant. If A is measured in square feet, and V in miles per hour, K = .0033.

The constant .0033 applies to the total resistance, and includes the now well recognized suction on the back of a moving body. For plane surfaces normal to the wind M. Eiffel found in his famous experiments that the suction accounted for one-third of the total. The frontal pressure alone may, therefore, be taken as $.0022\ AV^2$, and the horsepower required for every square foot of exposed surface is

$$\frac{.0022\ V^3}{375}, \text{ or roundly } \frac{6}{10^6}\ V^3$$

The value of this expression at 60 miles per hour is approximately one and one-fourth horsepower, and at 80 miles per hour three horsepower.



WIND RESISTANCE DIAGRAM.

If we know the "all out" speed in a calm, say, 70 miles per hour, numerical limits can be assigned between which the speeds will lie for any ratio of train to wind speed. These limits are shown in the diagram.

It will be readily understood without entering into calculation that the speed of the created wind creeps up as the strength of the natural wind increases, and that 80 miles per hour is quite a moderate figure to take for it, while the diagram shows how sharply the demand for power runs up with any increase of speed in that neighborhood.

We now know fairly well what should be the best shape for a body which is to be driven through the air at speeds of the order under consideration. The front should be quite "bluff," a sharply conical or wedge-shaped form not being at all the ideal to be aimed at. What is required is to eliminate every square inch of transverse flat surface that can possibly be dispensed with, smoothing off projections, and putting in gentle curves parallel to the natural flow of the air.

Pulverized Fuel in Brazil.

Some details of the use of pulverized coal on railway locomotives in Brazil are available from a report presented at the semi-annual meeting of the American Society of Mechanical Engineers. Two hundred and fifty locomotives have been equipped with pulverized coal and a number of tests were made that gave satisfactory results, full boiler pressure having been maintained throughout the test runs. The average analysis of the coal is given as follows:

Moisture	7.93 per cent.
Volatile Matter.....	29.80 " "
Fixed Carbon.......	43.07 " "
Ash	19.20 " "

The average number of thermal units per pound is 10,225. It was only by the adoption of a pulverized fuel system that the utilization of Brazilian coal became possible. This solution has therefore led to the development of the native coal fields of the country through the establishment of steamship and railway lines.

The report is very encouraging and is a positive proof that the same results could be obtained in many districts in other countries where the coal deposits may be of an inferior quality, but which could be utilized by the application of a comparatively economical process of pulverization that would render the coal available for the purposes desired.

Snap Shots—By the Wanderer

"The melancholy days have come, the saddest of the year," seemed an appropriate motto to adorn or disfigure the walls of railroad offices for many months past. The occupants of those offices were in the doleful dumps, and life was for them one "demned horrid grind." And it was tough. A man who has always been a subordinate and rather expects to be one till "time for him is no more," doesn't mind so much being directed in his duties by one who doesn't know. But for a man who has mastered his art, who knows what ought to be done and who has the initiative to do it, to be told by an ignorant overstrapper how to arrange his house and order his daily life, it certainly was tough and the prevalence of the doleful dumps and the melancholy days is easily explicable. Indeed, any other kind of a day would have been so utterly inexplicable as to leave the outside onlooker quite dazed and stupefied by the miracle of the thing. It simply could not have been otherwise than it was.

Men who held important posts in the army were very close-mouthed in the discussion of their superiors while the war was on, but now that they have been mustered out they have lifted the lid from their long pent up energies and are saying things about their whilom chiefs, that, to say the least, cannot be regarded as complimentary. We are wondering why all that time was spent and wasted in listening to Admiral Sims and his accusations. To be sure, what he had to say was well put and made mighty interesting reading, so far as details were concerned. But when he came to generalities of incompetency and inefficiency, he didn't say anything that the whole country didn't know and hadn't been talking about for two years and more. So in railroad matters. The top-notchers didn't seem to know much about the railroad business, and it was easier and safer for them or their chief clerks, who are suspected of having made the majority of the decisions, to refuse requests, to order an officer to "give the men what they ask," to cut off development and improvement by establishing standards to run a closed shop with a vengeance by even shutting the doors against visiting engineers, lest some of them might turn out to be "a chield amang them takin' notes," and to reduce managers and superintendents and motive power officers to mere clerks, who did not even have the usual clerkly satisfaction of having a duty to perform, knowing what it was, and doing it. Small wonder that the unrest of the workman extended to officialdom. But the great wonder, a wonder that speaks volumes for the loyalty and integrity of officialdom, is that so many men stuck to their posts throughout this whole regime of incompetent government interference and that there were so few desertions. You may talk and prate of loyalty and devotion, but for shining examples commend me to the superintendents and motive power officers who stood by through the gale. It is an old saying that no boss is so hard a boss to serve as the boss who doesn't know his job.

Now? Well, you remember how, in Daudet's Tartarin of Tarascon, the gallant Tarasconese hunters went out into the fields equipped cap-a-pie with all that the sporting shops could furnish. Fields that were as devoid of game as a city street. Then, how, in their exuberance at being freed from the confinement of office and shop, they tossed their caps into the air and shot them full of holes. So, it seems, I find the railroad officer. He does not really know what is ahead of him, except that he realizes that there is much of hard and constructive work. That it is not all skittles and beer that lies ahead of him, but rather work, work, work. Yet he feels a certain exuberance of spirit because the lid of repression has been lifted, and he has the sense of the return of the old possibility of using his own initiative and of working for superiors who know and understand and appreciate. He is far from settling back into a position of ease, but rejoices that now he can think and act as a man and his head has ceased to be merely something on which to hang his hat.

I have often wondered during these days of stress, when efficiency seemed to have become an obsolete symbol of the past, and the man-hour output of our shops had fallen forty per cent or more, how much of it was due to the demoralization of the men because of governmental protection and favor, and how much to the discouragement that had come to officers because they had been demoted from the position of a real officer, who was expected to think and act, to that of a virtual clerk who was only looked upon as one who was to listen and obey, and had lost all power to enforce discipline and arouse an *esprit de corps* in the men. A man usually does well that which he loves to do, and an irksome task is apt to be illy performed. Certainly, the task of serving an unknown master that was a bureau in Washington was irksome and must have had its influence. But now, as Tartarin-like hats are being tossed into the air, the likelihood of a better service and a return to at least a semblance of former efficiency seems to be one of the promises of the future.

And yet we can at least voice that high pean of praise which the cautious Scot lavished on a favored fellow man: "He micht be waur." So things might easily have been worse in the past, and promised to be much worse for the future. Had it been government ownership instead of government control; had politics entered into the management of the railroads, then, indeed, things might have been much the "waur." Fortunately, we were spared that. There was a dictatorship, and the people were in no mood to tolerate the interference of politics in the biggest industry of the country. But that is what would have come to us if the government had definitely taken over the roads. Again we were, perhaps, fortunate in having this try-out, that the public might have a taste of what they would get if a whole meal of the same class of viands were to be served.

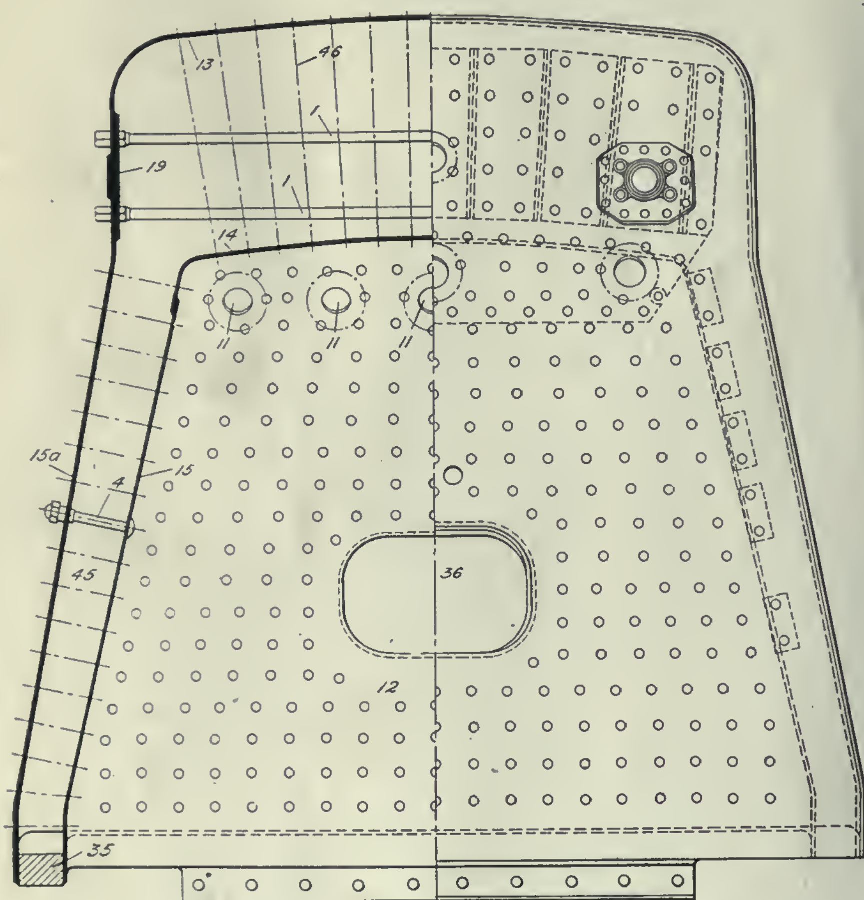
The thing now is, as to how much of that which was good can be preserved under the return. Will destructive competition have to be revived, or will it be possible to make agreements that will result in the economic benefits of all? The railroad administration issued orders and established a regime with the turn of a hand that would have or tried to have sent every officer of the railroads concerned to prison. And those of us who were outside the fold simply stood aside and wondered at the daring which accomplished such results. Of course, it's very easy for an irresponsible despot to order anything, but an inconsistency appears when, having ceased to be an irresponsible despot, he prosecutes those who try to do what he did. That we put up with it speaks volumes for our patriotism or is it that it is a nation-wide corroboration of Carlisle's old slur: "England is inhabited by forty million people, mostly fools"? And must we acknowledge that England has no monopoly, in the matter of the proportion of fools? At any rate, we have learned how some things can be done, and possibly why others cannot. And now we can only hope and pray that there will be enough of the hands-off spirit carried over to give us a chance to work out some sort of a salvation.

So there you are! There is rejoicing that the days of repression are of the past. There is hope for a rehabilitation of the mental attitude of the officials towards their work. There is a full realization that there is a rough and stormy road to travel before things can be brought to be as they were. But the will is there, and let us call hands-off until an opportunity has been given to get things righted. In this you and I and everybody must play their part, and not the least important part will be the throttling of the demagogue whose sole purpose in life is to fatten on the discontent of those of his fellows who, having brains, think not, while they themselves having heads that cannot, or at least, do not understand.

Details of Parts of the Pacific Type Locomotive as Shown in Our Chart, No. 12

The Boiler.

The boiler shown on the Pacific locomotive is one having what is known as a Belpaire firebox, so named from M. Belpaire, the original designer, who was an engineer of the State Railways of Belgium. The peculiarity in the construction of this firebox is that the stayed surfaces are parallel to each other and the staybolts are at right angles to the sheet which they support. This is clearly shown in the half rear elevation and section of the firebox. Here, in addition to the usual parallel sheets forming the water legs, the roofsheet is parallel to the crownsheet. This necessitates a flat surface in the roofsheet about 18 in. high on each side. To support this the cross stays (1) are used. The great advantage of this construction lies in the fact that a full and uniform thread can be secured in each sheet for every staybolt.



The firebox is fitted with a combustion chamber (39) about 3 ft. 8 in. deep, as well as with a brick arch (2), so that the whole space for the combustion of the gases after they turn the arch is about 8 ft. 9 in. The grate is 10 ft. 5½ in. long and 6 ft. 8 in. wide, affording a total area of 69.63 sq. ft. The brick arch is supported by 5 arch tubes (3).

The staying of the sheets is effected by the Tate flexible staybolts, which are spaced 4 in. between centers. The backhead is stayed by the braces (5) over that portion which is above the top of the crownsheet. These stays have jaws at the ends which are held by pins to the rear and front brace anchors (6 and 7).

As the distance across the side water leg and in to the first row of staybolts in the backhead runs from about 8½ in. at the bottom to 10 in. at the top, it is necessary to put in braces to stay this surface. Accordingly 5 side braces (8) are put in the water leg. These are riveted to the backhead by means of crowfeet (9) and to the outside sheets of the water leg by pads (10). At each corner, at the bottom, there is a washout plug. Plugs (11) are also located in the throatsheet and backhead opposite the arch tube openings in the inner sheet.

The backhead (12), roofsheet (13), crownsheet (14) and side (15) and back sheets (16) of the firebox are all ⅜ in. thick. The inside throatsheet (17) and back tubesheet (18) are ½ in. thick and the outside throatsheet (41) is 1 in. thick. The flat surface of the roofsheet above the crownsheet where the cross stays are attached is stiffened by a welt ⅜ in. thick laid along the inside face of the same. The outside diameter of the front course of the boiler (20) is 6 ft. 9 15/16 in. and the thickness of this and of the slopesheet (21) is 15/16 in. The distance between the tubesheets or the length of the tubes is 19 ft.

The boiler is fitted with a superheater, which is located in 40 superheater tubes (22), each 5½ in. outside diameter. There are also 236 firetubes (23) of 2¼ in. outside diameter. Each of these tubes is expanded into the tubesheets at each end and beaded (24) over at the firebox end.

The dome (25) is rather low because of the limitations imposed by the clearances. It is only 9 in. high above the boiler shell on the inside and is a pressed steel shape made of steel 15/16 in. thick.

The longitudinal joint of the shell of the boiler is a butt joint made up with an inside welt (26) 20⅝ in. wide and an outside welt (27) 12⅜ in. wide. The seam is sextuple riveted with 1¼ in. rivets. At the front the upper portion of the front tubesheet (28), which is ½ in. thick, is stayed by the front tubesheet braces (29) which are riveted to the shell by pads (30) and to the tubesheet by the crowfeet (31).

In the longitudinal section of the chart the feed water from the injector is shown as being delivered to the boiler along about the center line of the shell and near the front end. In the drawing of the boiler a variation of this is shown. The delivery pipe (32) is shown lying along the steam and water space and delivering water near the front end after traversing nearly the whole length of the interior of the boiler. This necessitates placing the injectors on the backhead, as is frequently done.

On the bottom of the shell there are also washout plugs (33), and a number of buckle plate tees (34) to which cross braces and buckle plates are attached. At the front there is the smokebox, which will be fully illustrated later and to a larger scale.

A great deal of work has been done by committees of the American Railway Master Mechanics' Association in developing the specifications under which boiler plates are manufactured. As they now stand, they require that the steel shall be made by the open hearth process and that what is known as firebox steel shall conform to the following chemical requirements:

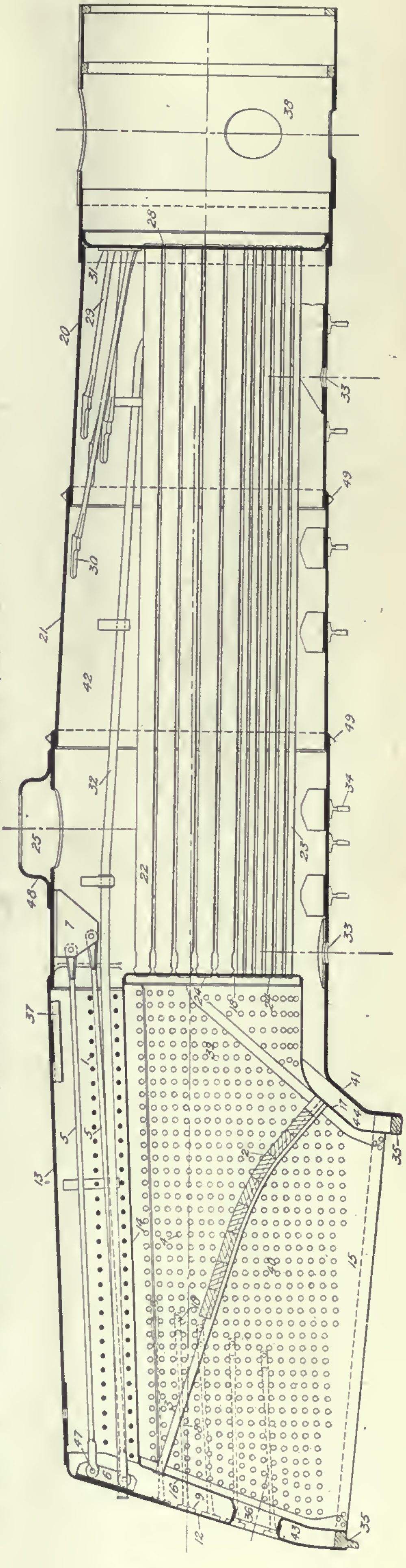
		Per Cent.
Carbon		0.12 to 0.25
Manganese		0.30 to 0.50
Phosphorus, not over	acid.	0.04
	basic	0.035
Sulphur, not over		0.04
Copper, not over		0.05

As for physical properties, the ultimate tensile strength must lie between 52,000 lbs. and 62,000 lbs. per sq. in. and the limit of elasticity be one-half the tensile strength. The sextuple riveting used for the longitudinal seams makes a joint

about 86 per cent as strong as the full plate. If we assume that the ultimate tensile strength of the shell steel to have been 60,000 lbs. per sq. in. and the limit of elasticity 30,000 lbs., then with a longitudinal seam of 86 per cent efficiency the ultimate and yielding strength of the shell would be total internal pressures of 90,300 lbs. and 45,150 lbs., respectively, which is equivalent to steam pressures of 1,125 lbs. and 513 lbs. per sq. in., respectively; or, if a working pressure of 200 lbs. per sq. in. be used, a factor of safety of 5.5 or 2.75, according to the basis on which it is calculated.

The following is the list of parts of the boiler to which reference numbers are attached:

1. Cross staybolt.
2. Brick arch.
3. Arch tube.
4. Tate flexible staybolt.
5. Backhead brace.
6. Rear backhead brace anchor.
7. Front backhead brace anchor.
8. Backhead side brace.
9. Crowfoot of backhead side brace.
10. Pad of backhead side brace.
11. Washout holes for arch tubes.
12. Backhead.
13. Roofsheet.
14. Crownsheet.
15a. Outside side sheet.
15. Inside side sheet.
16. Back firebox sheet.
17. Inside throatsheet.
18. Back tubesheet.
19. Cross stay welt.
20. Front course of boiler.
21. Slopesheet of boiler shell.
22. Superheater tube.
23. Firetube.
24. Tube beading.
25. Dome.
26. Inside welt of longitudinal seam.
27. Outside welt of longitudinal seam.
28. Front tubesheet.
29. Front tubesheet brace.
30. Front tubesheet brace pad.
31. Front tubesheet brace crowfoot.
32. Feed water delivery pipe.
33. Shell washout holes.
34. Buckle plate tee.
35. Foundation or mud ring.
36. Firedoor opening.
37. Welt for safety valve opening.
38. Smokebox.
39. Combustion chamber.
40. Firebox.
41. Outside throatsheet
42. Boiler shell or barrel.
43. Back water leg.
44. Front water leg.
45. Side water leg.
46. Crownsheet staybolt.
47. Backhead brace pin.
48. Dome shell.
49. Circumferential riveting.



Molybdenum.

Among other results of the Great War it is noteworthy that it has taught us the importance of molybdenum as an alloy in the manufacture of steel. This is peculiarly the age of steel alloys and steel manufacturers are dependent on fine alloying elements—nickel, chromium, tungsten, vanadium and molybdenum. They are the chief alloys that have been proved commercially practical. And only now are manufacturers learning what the war has taught of the tremendous possibilities of molybdenum steel.

The United States is compelled to import practically all of its nickel, vanadium and chromium used in the steel industry. Tungsten and chromium, while mined in this country, are far from plentiful here; before long the former, too, must be imported. Thus for four of the five alloying elements, the United States is dependent on foreign supply. But of molybdenum ore we have a practical monopoly.

The discovery of the molybdenum deposits in Climax, Colorado, and the use of this ore in producing a new steel alloy on a commercial scale assures the United States of world independence in the production of high grade alloy steels. The Colorado deposits of molybdenum represent from 60 to 80 per cent of the world's supply. The mines there, tapping the proverbial "mountain of ore," are already developed to 1,000 tons of ore a day, and have not attained as yet anything like maximum production.

As to the effect produced by the war it may not be generally known that a great stimulus to the development of molybdenum steel was given by the need of a light, tough steel for use as armor plate for fighting tanks, for helmets, and for gun shields, as well as for crank shafts and connecting rods for airplanes.

Lumberjack Railroads in the Mountains

By John B. Woods, F. E.

There are two extremes of railroad building for the logging engineer; flat land work and mountain work. Often it is comparatively easy and inexpensive to construct good track where the ground is level and devoid of rock outcroppings. Often it is not so easy, where swamps and bottom lands intervene, and where the first construction is but the beginning of a long fight against flood water and crumbling earth., The old-time loggers often hit upon the expedient of locating these wooden railroads in the valleys and moving the logs out over them upon small four-wheeled cars. Once such a road was completed it endured for several years and was much more reliable than the muddy wagon roads or skidding trails through these valleys. There was so much timber available and close at hand that no great problem of hauling to track was encountered.

Then there came the incline, as the timber receded toward the mountain tops, for the gradients were so heavy that animals simply could not pull empty cars back to the woods, and the later developments of steam motive power were unavailable. Of course the incline was a dangerous affair in operation, built often with grades as high as forty per cent. A straight course was cleared from the summit to the base of a given hill, and a single line of track laid down, with a double turnout and passing track midway. At the top a great sheave was anchored firmly and equipped with braking device. A short loading spur was located on the summit and when the loaded car was ready to descend it was attached to the lowering cable and let in upon the incline. As it traveled downward by force of gravity an empty car at the lower end of the cable was pulled upward, and they passed each other midway.

The later and more general development of mountain railroading by the lumber industry has been founded largely upon the great tractive power of relatively light-weight geared-locomotives. These slow moving giants are able to negotiate heavy grades with long strings of empty log cars and even with shorter trains of loads. Second only to the value of the locomotives' pulling and pushing abilities is the holding power and reliability of the air-brake. Sometimes the latter agency is more important than the former, but of course the two are inseparable from the logger's point of view. A third consideration that has made logging by steam possible even where sparse stands of timber reduce the traffic over a given spur track to a matter of four short trains daily during two or three months is the fact that the geared locomotive, moving only three or four miles per hour, can travel safely over track that is very rough and poorly ballasted.

There are two principal types of logging railroads in the hills. They follow the conditions of tree growth. If the stand of timber is dense, as is the case on the western coast, it is entirely practicable to handle the logs from the stump to the mill entirely by steam power. They may be brought to the track by means of great skidders, mounted upon specially designed cars; they are loaded either by the same machines or by mobile loading cranes, also mounted upon cars; and then the geared locomotive hauls the loaded cars away to the main line where a faster engine completes the journey at fair speed. The use of this heavy steam machinery necessitates building of well ballasted roads, and the great cost of these roads is justified by the enormous quantity of timber that can be handled over a single short spur line. In sparse stands, where steam logging is not economically feasible the logs are brought to trackside by animal power. Sometimes they are loaded upon cars by hand or by teams and cross-haul devices. More often a mobile log-loader is used that travels along the car-decks upon steel rails under its own power.

FIG. 1—BUILDING A MOUNTAIN GRADE. FIG. 2—ONE TYPE OF SKIDDER IN THE HILLS, POOR TRACK IN USE. FIG. 3—LOADING LOGS BY HAND IN THE MOUNTAINS.

Nautrally the valley is the site of the spur track whenever it can be located there. And in rocky, tortuous ravines the builder must keep far enough above flood level to avoid washouts, without going so high as to miss entirely the occasional fairly level reaches. Usually he must keep his grade climbing upward so as finally to gain the hilltops or the fairly level plateau that so often is found at the ravine's head. As has been stated before he avoids all the rock-work possible, but much such work usually is necessary. And when he has carried his survey up a winding ravine with a consistent and workable grade he finds often that a jumping-off place is reached and there is nothing left but to bridge. Bridging is a costly and dreaded task often, and many errors are made in the way of avoiding bold strokes of engineering. There is a tendency to cling to the river course and cross and re-cross rather than get above it too far. The sum expended in many short bridges sometimes is greater than would be necessary for one or two longer and higher structures, and the washout losses may multiply the original expense. The happy medium is found by the logging genius. In building bridges there are only two requirements, strength and cheapness. If a structure can be taken down and re-used there is a distinct saving in material, but usually the life of a bridge on a spur track need not be more than two or three years at most. In swift streams piling bridges are favored because of their stability during flood time. Where the stream flow is not an important consideration the mud-sill structure is used, or even the old-fashioned cribwork of round logs. Comparatively few long spans are put in by loggers except upon main lines or permanent spurs, and where such spans are used they generally are built of steel.

When the logger wishes to climb a mountain slope away from the ravine he often builds switch-backs, keeping the grades down to seven or eight per cent or less if possible. The switch-back offers an advantage in that a whole mountain face may be cleared of timber without the necessity of bringing any logs over long distances, as the track zig-zags across the entire slope.

Occasionally railroads are adapted to peculiar conditions in ways that are strange to orthodox engineers. In southern Oregon there are logging companies that build track into kettle holes in order to get great quantities of logs. Sometimes the grades are too steep to be negotiated by geared locomotives. In that event the loggers install great donkey engines at the summits of the inclines and pull the loaded cars with cables out to a point where they can be picked up by the locomotives. Conversely, trains are lowered to mainline level sometimes by cables and the empty cars hauled back up by the donkey engines. In short railroad logging as a business is a strange mixture of engineering skill and rule-of-thumb expediency. But during the past decade it has grown in importance and with the universal adoption of steam railroads as a means of transporting logs the projects attempted have earned the attention of railroad builders throughout the country.

Hardening Steel Tools.

The many improvements that have been made in furnaces and other appliances are such that the means of properly heating and hardening steel tools are well known not only to superintendents, but also to machinists and tool makers generally, and to blacksmiths and tool hardeners particularly. In many of the older kinds of shops, especially railroad repair shops, however, the appliances are still primitive, and such means and methods as blast ovens, lead and cyanide baths are unknown, or known only in name. Hence much is left to the mechanic, skilled or unskilled, to find ways and means of keeping the cutting tools in such condition as will meet the expectation of the user.

Generally speaking in dealing with tool steel, it is well to be advised of the kind of steel used, the form of the article, and, above all, the use to which it is to be put. A failure of the tool will usually be attributed to the lack of skill on the part of the mechanic making and tempering the tool rather than to any shortage of apparatus to produce the best quality of tool calculated to perform the desired operation successfully. Among other difficulties it is not infrequently found that it is next to impossible to heat and harden the tool in its entire length, and unless this is done, it should not be expected that the result will be other than more or less disastrous. Much ingenuity is often displayed in finding means whereby the heating may be equally applied to the entire article.

An incident is related by E. R. Markham, a well-known authority on the annealing and hardening of steel, in regard to a tool maker heating a long, taper reamer. The only means of heating furnished by the shop was an ordinary blacksmith's forge, the mere building of a large, high, coal fire was not satisfactory, so the fire was cleaned out of the forge, and two rows of fire-brick were laid on the forge, as shown in Fig. 1. Upon these were placed pieces of wire about one-half inch apart, and two rows of brick laid on top of the wires securely holding the wires in place. The upper compartment thus formed means that could be used as an oven when a fire of charcoal was built upon the wires between the bricks. By placing bricks at the openings at the ends, a good fire was obtained in which the reamer was heated in its entire length in a very satisfactory manner.

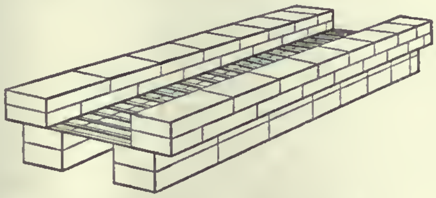


FIG. 1. VIEW OF STRUCTURE FOR HEATING A LONG REAMER.

Temporary appliances of this kind should not, however, be resorted to unless in cases of extreme emergency. A clever mechanic who can get along with makeshifts, will find that in these days of high costs, that his ingenuity will not infrequently add to the difficulty of getting anything better. Many ingenious devices, however, are in use and, comparatively, little heard of, until they come under the eye of some practical engineer who has the desire and opportunity to call attention to them, and, if worthy, they find a place among other improved useful appliances. In this way the hardening of small taps, reamers, counterbores and the like have called into activity the ingenuity of clever mechanics who have devised ways and means of obtaining the desired end.

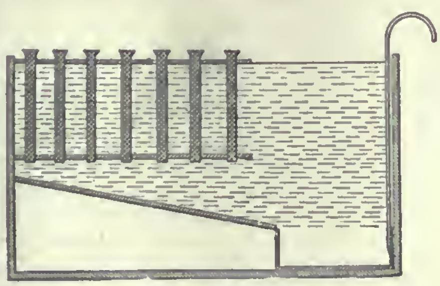


FIG. 2. BATH FOR HARDENING TAPS AND REAMERS.

Among other contrivances Fig. 2 shows a section run of a bath designed for taps and reamers. When a piece was heated to the proper temperature, it was taken by means of a pair of tongs and dropped into a bath, which consisted of a tank having several tube-shaped pieces of wire netting, as showing in the sketch. The tubes were slightly larger inside than the diameter of the largest part of the tool being hardened. Tubes of various sizes were used, the size depending on the diameter of the tools to be hardened. The tank had a supply pipe coming up from the bottom. This was supplied with a supply tank overhead. A pump was used to force the water into the supply tank. It was possible to use a bath of clear water, brine, or any favorite hardening solution. As fast as the pieces were heated to the desired temperature, they were taken with tongs and dropped into one of the tubes, the cutting end being down. They passed down through the tubes on to aniline, and then into the catch pan, as shown. The distance the pieces travelled in the bath was considered when designing it. It was found by experiment that the largest piece to be hardened would cool below a red heat in falling a distance of two feet in the bath. To make satisfactory results a certainty, the depth of the part of the tank through which the pieces passed was made 36 in. long. If the tools had struck the bottom and turned on their side before the red had disappeared from the surface, they would have in all probability, sprung; but, as it was, excellent results were obtained.

Need of Locomotives in Italy.

Italy recently purchased 300 locomotives from the United States, but is now looking to Germany as a source of supply because of the low purchasing power of the lira in the American market. It is a question how soon Germany will be able to satisfy any foreign demands of this sort, however. At the conclusion of the war that country possessed between 12,000 and 13,000 locomotives, 4,000 of which the Allies took under the terms of the peace settlement; so that to-day Germany stands in more acute need of locomotives than does Italy.

With adequate facilities Italy has been able to turn out high-class locomotives, and such concerns as Ansaldo are engaging in their manufacture. But Italy occupies an inferior position in the matter of raw materials. Italy does not lack skilled workmen in this branch of industry, but the present labor situation is decidedly unfavorable, and these two hindrances of labor difficulty and the shortage and high cost of steel, which must be imported, combine to make it impossible for Italy to produce locomotives as cheaply as they can be supplied from abroad.

The situation, therefore, is such that Italy, for the time, must continue to purchase from foreign sources, and until Germany is prepared to supply the demand the United States must be relied upon, in spite of unfavorable exchange, for whatever locomotives are imperatively needed.

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What to Expect in Reconstruction.

Looking for an immediate solution of the difficulties that have encumbered the transportation problem is looking for too much. All railroad men of experience agree that it will take at least a year before any marked improvement can be made. One gratifying evidence is already apparent to every one. There is a better feeling among the men who live and move and have their strenuous being in doing the actual work necessary in running the intricate machinery with the equipment, such as it is; and until the possibility of improving the equipment is accomplished we should not look for miracles.

This is particularly true of the mechanical department. As is well known, the repression policy of the Interstate Commerce Commission had reduced the means of maintaining the equipment to a minimum long before the war period, and during the period of governmental control, even with increased rates, the equipment went from bad to worse. In the single item of locomotive construction, taking the approximate number of locomotives in service as 65,000, with an average working life of less than fifteen years, less than one-half of the number of new locomotives needed were placed in service, and this vital shortage cannot be made up in a day. In the matter of cars it is even worse, and while the constructors are prepared to meet the emergency, nothing short of a prompt and generous increase of capital can meet the pressing emergency.

In the measures promulgated by the Government there is no guarantee or anything approaching a guarantee of income. It may be admitted that it is recommendatory that in so far as it may be practicable the Interstate Commerce Commission shall make rates that will yield a net operating income of 5½ per cent upon the true value of the railway property. At the best, it may be taken as an assurance that the Commission will make an honest effort to adjust rates upon the basis specified, but knowing as we do the slow speed at which all governmental commissions work, we will be agreeably surprised if there is any marked degree of real progress before next winter's frost is upon us with its inevitable disasters.

Progress in Automatic Train Control

As previously reported, six railroads are now using the automatic stop in selected portions of their track. The two tests now regarded by railroad men as the most important are those of the Chicago & Eastern Illinois and the Chesapeake & Ohio. The former has 106 miles of double track covered; it has been in use since 1914, after several years of experimenting and testing. The equipment, on account of results achieved, is now regarded by some as permanent. On the Chesapeake & Ohio a different system is installed on 21 miles of track. The Rock Island is now installing a third system.

Theoretically, the block signal system which controls the movement of trains on the basis of space instead of time, is collision proof. The road is divided into spaces, usually a mile in length and only one train may be in movement in a space, or block, at one time. Actually the block system is a great protection; all the better roads in the country embracing more than 100 miles of track are using the system in one form or another. But even on those roads, highly developed because of heavy traffic, where the best type of the block signal system is installed, collisions sometimes occur. Of fifty-three collisions which the Interstate Commerce Commission investigated in 1919, twenty-eight happened on lines operated under some form of block signal system. Eighteen of the twenty-eight occurred in automatic block signal territory. In the previous year twenty-six of the sixty-three collisions took place on block-signaled lines. An analysis of the figures of 1919 shows that eleven of the eighteen collisions in automatic block signal territory were due to failure of the enginemen to observe and obey signal indications. Two of the worst ones of the year were in this class.

This is where automatic train control enters on the situation. Its purpose is to remove the element of human fallibility, to bridge, by an unfailing automatic connection, the gap between the signal and the train. Automatic train control is not offered as a cure-all for loss of life on railroads. On the many miles of track yet without any form of the block system there is no place for most of the devices offered, but in its field (and that is the important one of the heaviest traffic areas in the country) its champions say the adoption of automatic train control is the only way to reduce to a minimum the element of risk that remains in the most highly developed automatic block signal systems.

The Automatic Train Control Committee, composed principally of railroad men, recommended further tests before adoption of a device for general use. This has provoked criticism from those promoting automatic train control. Referring to the successful use of automatic train-stop devices in New York and Boston and other places for handling urban traffic, the committee said:

"The fact that automatic train-stop devices are operated with a high degree of success on certain underground and elevated tracks cannot be regarded as conclusive evidence that such devices, or devices of other types intended to accomplish similar results, would be practical for use on tracks in the open country, subject to entirely dissimilar operating conditions. On the tracks where these devices are in successful use trains are run for passenger service and their equipment is uniform in character; they are moved at comparatively moderate speeds; clearance conditions are uniform, and there are no weather conditions to interfere with proper operation. On the roads in the open country, on the other hand, the equipment of trains is not uniform, and the variation in train speeds is great; there is also great variation in the length and weight to trains. Clearance and weather conditions in the open country also present difficult problems which are not present in underground and electric tracks.

Increased Rates on Foreign Railways.

In approaching the question of the raising of rates on the American railroads, doubtless the Interstate Commerce Commission will, in its wisdom, find time to glance at the action that foreign countries have been compelled to take, and, if need be, take a lesson. It must be admitted that our Federal and State Commissioners have been slow to learn in the past, but it is to be hoped that the pressure of circumstances will not altogether fail in producing such increase in rates as will, in some measure, meet the requirements of the situation.

Glancing briefly at the action of the French government, it will be recalled that in March, 1918, an increase in railway rates of 25 per cent was established in the hope of making up the growing deficits. The measure proved to be entirely inadequate. The government has, therefore, been forced to face the necessity of imposing a new general augmentation of rates. In February of the present year the Minister of Public Works was authorized to put in effect for the remainder of the year a new general increase in railway rates on the large railway lines of general interest, and on the belt railways of Paris, as well as on the private connecting lines, amounting to 45 erp cent for third-class tickets, 50 per cent for second-class tickets, 55 per cent for first-class tickets, and 115 per cent for merchandise, which is added to the increase of 25 per cent authorized two years ago. The augmentations do not apply to season tickets actually delivered at the old rate to workmen, employees, and persons attending schools. Other concessions are made to families having certain numbers of children, and to mutilated or discharged soldiers. The receipts will figure as a special account of the French treasury, and they will be distributed among the railways, having due regard to the requirements of each railway.

The Belgian government has just approved a general increase of 100 per cent on travelers' tickets and on merchandise. During 1918 and 1919 the increase in the railways tariffs in Germany have ranged from 35 to 110 per cent for travelers, and 125 per cent on merchandise. In addition, a new general increase of 100 per cent is announced this month.

The railway rates in Austria have been augmented 100 per cent for travelers and 240 per cent for freight. Hungary has increased the rates 300 per cent. In Italy the rates for travelers have been increased by 50 to 100 per cent, and on merchandise 140 per cent. Great Britain has raised its rates on travelers 50 per cent, and on goods by 25 to 100 per cent. Switzerland, that had no hand in the world war, has raised the railroad rates on passenger traffic 100 per cent, and on merchandise 180 per cent. Sweden is still higher than the Swiss railways, while Holland and Norway are equally high. Spain seems to be getting along in its primitive way with less increases, but it needs improvement, and might as well come up to the rate where betterments are possible. In our own favored land the politicians are not in such a hurry. They love to hear themselves speak before taking action, but we may as well make up our minds that there is something coming, or more properly speaking, there will be something going away from us when we have occasion to use the railroads.

Train Dispatching in France.

After years of skepticism and distrust of the American system of train dispatching, and only after a demonstration of its efficiency had been made by the members of the expeditionary force, the officials of one of the great French railroads, the Orleans, have decided to give it a trial.

The intensity of traffic caused by the war, and the changes necessarily made in the ordinary methods of transportation, increased the amount of business handled at certain points in enormous proportions. The result was a congestion at some of the stations and a complete blockade at a number of connecting points. Then, the effect reacting upon the cause, the scarcity of rolling stock and men was still further intensified by the delays and defects of every kind putting demands upon some of the lines that they were not prepared to meet.

In order to reduce these troubles and improve the service, the officers of the American military administration of railways in France suggested a trial of the despatching system that is used with such success in the United States. The suggestion was accepted and a trial of the system was made on the Orleans Railway. The trial, which was, at first, limited to the division from St. Nazaire to Saumur, was afterwards extended from Saumur to Gievres. This was done because of the American custom of having a despatcher cover a zone equal to the longest run of the locomotive. Because of the success attendant upon this method of train handling the application of the system was still further extended, and now, that the American military control has been withdrawn, it is proposed to make an extensive trial of it under French management.

Up to the time of the departure of the Americans, the work was done in a slavish imitation of the practice in the United States. The normal conditions of French railway operation require that that practice shall be materially modified and, while still based upon the American system, its adaptation to the needs of the country of its adoption is a comparatively easy matter.

The despatchers will use a telephone of the type employed by the Western Electric Co. They will work in the same way as American despatchers, with the difference that instead of giving orders to the train conductors, they give them to the station masters or agents, who have control of train movement in the French organization.

Like our own despatchers, they have a large train sheet upon which is noted every report received by them from the different stations. It is stated that one of the principal advantages derived from the system is the reduction of lost time for the engines especially on divisions of heavy traffic. Before the system was put into effect, the delays from various causes were very frequent; and, for different reasons, increased as the trains approached certain large stations. Engines at division terminals sometimes stood waiting for several hours the arrival of trains that they were to take out. This, of course, increased the length of time that the crews were on duty, and can be seen to be a useless waste of time. Under the despatching system the engines are held in the house until just before the arrival of their trains, when they are sent out.

The French criticism of despatching is interesting because it practically amounts to an almost unqualified approval of it for handling trains.

That full and almost instant information is at hand regarding the situation of every train on a division; that there is an opportunity for the rapid transmission of urgent orders to stations and engine houses, by which the probable time of arrival of trains can be given and a premature preparation of engines and equipment avoided; that it is possible for every engine house and station to obtain all the information for which they have any need; that useless engine houses can be done away with; that it is possible to get good results when sending out trains out of turn; that it is possible to keep track of trains ordered and to watch full trains standing in the yard; that a limit can be put on running time before a congestion occurs and relief can be afforded to an overloaded line; that, in case of accident or unexpected incidents, it will be possible for the central office to take the necessary steps to direct the movements with the greatest co-ordination, as soon as the information is received; better than a station agent whose knowledge of the situation covers only a limited area.

At first the operation of the system is burdensome. It requires a number of employes at the central office, an operator at each station and perfect maintenance of the telephone line.

Secondly, there is a tendency for despatching to do away with the initiative of the local agents, which is not without its disadvantages, under the regime of the French railways, where the conductor is not in charge of the train movement, as he is in the United States.

But, taken all in all, the situation is summed up as facilitating train movement by making it more regular; as making a heavier traffic possible with a better utilization of engines and equipment. So that the result of Colonel Slade's introduction of American methods in the handling of the expeditionary force may be the adoption of the American method of train despatching by the French railways.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page* 84, *March*, 1920.)

1131. Q.—What may cause an increase in brake cylinder pressure after a light application of the brake?

A.—Leakage into the application cylinder of the distributing valve.

1132. Q.—Where can this leakage be from?

A.—Either from the main reservoir or the pressure chamber.

1133. Q.—Where is the main reservoir leak usually from?

A.—Through the rotary valves or body gaskets of one of the brake valves.

1134. Q.—Could it enter through any other source?

A.—Yes, through the brake cylinders past a worn application piston packing ring provided that there was considerable resistance to the movement of the application portion of the distributing valve.

1135. Q.—Where is the pressure chamber leak usually from?

A.—The equalizing slide valve of the distributing valve.

1136. Q.—What type of distributing valve is the 6-A?

A.—The retarded application or modified type.

1137. Q.—How is this valve distinguished from the standard type?

A.—By the additional exhaust port in the body of the valve at the side of the equalizing slide valve bushing.

1138. Q.—What difference is there in the ports through the equalizing slide valve, graduating valve and bushing?

A.—None, except that in the retarded valve an additional port leads from the pressure chamber through the graduating valve, slide valve and seat, to the reduction chamber in the filling block, and another port opening leads from the slide valve seat to the exhaust port mentioned, which is near the safety valve connection.

1139. Q.—Where is this reduction chamber located?

A.—In a filling block between the distributing valve and the reservoir.

1140. Q.—When is the port from the pressure chamber to the reduction chamber open?

A.—As soon as the equalizing piston and graduating valve respond to a brake pipe reduction.

1141. Q.—When is the pressure exhausted from the filling block chamber?

A.—As soon as sufficient difference in pressure is obtained to move the equalizing slide valve to service position.

1142. Q.—How is foreign matter sometimes successfully removed from the piston seat?

A.—By withdrawing the brake pipe pressure with the valve in service, then closing the cut out cock in the brake pipe under the brake valve and moving the valve handle to running or release position.

1143. Q.—This does what?

A.—Starts a heavy blow at the brake pipe exhaust port that tends to remove any obstruction from the seat.

1144. Q.—Why should the brake pipe pressure be withdrawn with the valve in service position, before the brake valve cut out cock is closed?

A.—To prevent foreign matter, especially if metal, from becoming imbedded in the brass seat of the equalizing piston.

1145. Q.—How would closing the cock before draining the brake pipe tend to imbed any metal in the seat?

A.—Closing the cock first, the brake pipe pressure between the seat of the valve and the cut out cock would quickly escape, leaving full equalizing reservoir pressure to force the valve to its seat.

1146. Q.—Does this apply to all types of brake valves?

A.—All except those with the collapsible equalizing piston.

1147. Q.—Why not to them?

A.—As soon as the equalizing reservoir pressure is two lbs. higher than that in the brake pipe, the pressures equalize and the piston cannot be driven against its seat with any particular degree of force.

1148. Q.—How is it ascertained whether a brake valve has a solid or collapsible equalizing piston without taking the brake valve apart?

A.—By placing the brake valve handle on lap position and opening an angle cock, and noting the drop in equalizing reservoir pressure.

1149. Q.—What will a valve with a solid or standard piston show?

A.—A very slow drop in equalizing reservoir pressure.

1150. A.—What does the slow drop represent?

A.—Leakage past the equalizing piston packing ring.

1151. Q.—What will be shown if the valve has a collapsible piston?

A.—A rapid drop in equalizing reservoir pressure due to the piston collapsing and discharging the equalizing reservoir pressure into the brake pipe.

1152. Q.—What is the tension of the spring in the signal line non return check valve?

A.—From 1 to 2 lbs.

1153. Q.—What is the difference in pressure maintained by the spring in the check valve of the dead engine fixture?

A.—About 20 lbs.

1154. Q.—What is the effect of using the dead engine check valve spring in the signal line non return check?

A.—With 45 lbs. pressure in the reducing valve pipe, there will be but about 25 lbs. in the signal system.

1155. Q.—Why is the heavier spring used in the dead engine fixture?

A.—So that in freight service, with 70 lbs. pressure in the brake pipe, but 50 lbs. pressure will be obtained in the main reservoir of a dead engine being hauled in a train.

1156. Q.—What is relied upon to operate a signal whistle on a locomotive, a sudden or a heavy reduction in signal line pressure?

A.—A sudden reduction rather than the volume discharged.

1157. Q.—Is it possible to hold the car discharge valve open too long a time to secure the desired blasts of the whistle?

A.—Yes.

1158. Q.—In just what way?

A.—With a short train the withdrawal of an excessive amount may reduce the signal line pressure to a point where it would be too low to operate the signal valve correctly.

1159. Q.—What causes undesired blasts of the signal whistle.

A.—Leakage in the system and a reducing valve that will not open promptly and supply the leakage.

1160. Q.—What causes blasts only at a time the independent brake valve is used?

A.—It is generally due to a defective seat on the non return check valve.

1161. Q.—What is it particular to observe when renewing the seat of a check valve?

A.—That the valve is not bent and that its wings are in line with the seat, and that the cross section of the seat is parallel with its depth.

1162. Q.—How can a valve out of alignment with the seat be detected?

A.—By the seat only bearing on one side after renewal.

1163. Q.—What else must be observed when making repairs to the check valve?

A.—That the screens holding the curled hair in the strainer part are clean. The hair should also be removed and cleaned.

1164. Q.—What usually causes the signal to fail to operate on long trains of cars?

A.—A diaphragm stem that is too loose in the bushing in the signal valve.

1165. Q.—Can anything else cause it?

A.—Yes, the diaphragm itself may be too baggy.

1166. Q.—How would the signal valve fail to operate in the latter event?

A.—The diaphragm may partly move as the result of the signal line reduction, but be baggy enough to fail to lift the diaphragm stem.

1167. Q.—What may cause two blasts of the whistle for one pull on the car discharge valve cord?

A.—A very loose fitting diaphragm stem.

1168. Q.—What is the effect of too neat a fit of the stem in the bushing?

A.—Too long a blast of the whistle and usually undesired blasts.

1169. Q.—How could the neat fitting stem itself cause a blast?

A.—It would not, but leakage would affect it that would otherwise have had no noticeable effect on a correctly fitted valve.

1170. Q.—How are signal valves repaired?

A.—If accurate results are desired they are returned to the manufacturers, who repair them free of charge.

(To be continued.)

Train Handling.

(Continued from page 85, March, 1920.)

1175. Q.—How much higher must the brake pipe pressure be to move the equalizing piston toward release position?

A.—From 1½ to 2 lbs. higher than the pressure in the pressure chamber.

1176. Q.—What important connection is made when the equalizing piston moves toward release position or assumes what is known as preliminary release position?

A.—The chamber in which the release slide valve operates is momentarily opened to the reduction limiting chamber exhaust port so that a sudden drop in pressure takes place in the release slide valve chamber as a result of the release piston and slide valve are promptly returned to their release position which is then termed secondary release position, occurring before the equalizing piston and slide valve can return to their release positions.

1177. Q.—Why does the equalizing piston and slide valve momentarily stop in what is known as secondary release position?

A.—Because of the connection from the pressure chamber to the outside end of the small end of the equalizing piston and the action of the equalizing piston stop spring.

1178. Q.—What action insures the return of the equalizing piston and slide valve to release position?

A.—The release slide valve opening the chamber at the lower end of the equalizing piston to the atmosphere through the equalizing slide valve exhaust port.

1179. Q.—How is the brake then released?

A.—By the release slide valve opening the application chamber through the application chamber exhaust port to the atmosphere.

1180. Q.—What returns the application piston to release position?

A.—The pressure in the service brake cylinder.

1181. Q.—Is there any other way of making a release beside the direct method explained?

A.—Yes, if the graduated release cap is in graduated release position.

1182. Q.—What is the difference in this case?

A.—The turning of the graduated release cap makes an opening from the emergency reservoir through the equalizing slide valve into the release slide valve chamber when the equalizing slide valve is in release position so that the pressure chamber will be supplied or charged from the emergency reservoir when the control valve is being operated in graduated release.

1183. Q.—How is the release of brakes then graduated?

A.—If the increase in brake pipe pressure ceases, the inflow of emergency reservoir pressure into the pressure chamber will drive the release piston toward application position far enough to cut off the inflow into the release slide valve chamber and at the same time the release graduating valve will close communication between the application chamber and the atmosphere thus holding the brake partially applied.

1184. Q.—How is the service reservoir charged after an application and release of the brake?

A.—From the emergency reservoir through the charging valve until the pressures have equalized after which both of the sreervois are charged from the brake pipe as explained.

1185. Q.—How is the charging of the service reservoir governed?

A.—By the pressures effective on the ends of the charging valve.

1186. Q.—Why is the charging valve made with pistons of unequal size?

A.—So that it will be in its upper position and open the emergency reservoir to the service reservoir before the pressure chamber pressure is equal to the emergency reservoir pressure.

1187. Q.—Why is the charging of the service reservoir intentionally delayed?

A.—So that no brake pipe pressure will be absorbed during a release of brakes.

1188. Q.—When does emergency or quick action operation occur?

A.—When the brake pipe pressure is reduced at an emergency rate or when the pressure chamber and reduction limiting chambers have equalized through an over-reduction of brake pipe pressure or leakage.

1189. Q.—Which slide valve governs the emergency operation?

A.—The release slide valve.

1190. In what position?

A.—The position assumed when the release graduating spring is compressed at which time the release piston and slide valve have traveled the full stroke.

1191. What is an emergency rate of brake pipe reduction?

A.—A drop of about 8 lbs. per second.

1192. Q.—In over position, it has been explained that the pressure and application chambers have equalized at 86 lbs. per square inch, at what figure does the pressure chamber thereafter equalize with the reduction limiting chamber if the brake pipe reduction is continued?

A.—At about 60 lbs.

1193. Q.—When will quick action then occur?

A.—If the brake pipe reduction is continued until the tension of the release graduating spring is exceeded or when the brake pipe pressure is at about 54 or 55 lbs.

1194. Q.—What four principal port openings are made in the release slide valve seat when the release slide valve is moved to emergency or quick action position.

A.—The chamber at the large end of the emergency piston is opened to the atmosphere through the release slide valve exhaust port. The release slide valve chamber is opened directly to the application chamber, the emergency reservoir and the quick action piston chamber through the quick action closing valve.

1195. Q.—How is the emergency portion of the control valve affected when the pressure is exhausted from the chamber at the large piston end?

A.—Emergency reservoir pressure being on the inside of the double ended piston, and the movement of the slide valve having severed the connection from the outside of the small end of the emergency piston to the atmosphere, the sudden removal of the pressure from the chambers at the large end of the piston causes it to instantly travel to its upper position and move the emergency slide valve to connect the emergency reservoir directly to the emergency brake cylinder.

1196. Q.—What else does the emergency slide valve do?

A.—Opens the chamber on the brake cylinder side of the application piston to the emergency brake cylinder at the same instant that the slide valve moves.

1197. Q.—For what purpose?

A.—To create a sudden drop in the pressure on the brake cylinder side of the application piston (if the brake has been previously applied with a service application) so that the movement of the application piston to application position will be instantaneous to equalize the service reservoir and the service brake cylinder.

1198. Q.—Why is the opening made to the quick action chamber?

A.—To drive the quick action piston downward and unseat the quick action valve and exhaust brake pipe pressure to the atmosphere for the propagation of quick action, throughout the train.

1199. Q.—Are there any special rules for handling brakes on cars equipped with the PC brake?

A.—No it should be handled as is considered good practice with other types of brakes.

1200. Q.—What is meant by the "UC" brake?

A.—The universal control equipment.

1201. Q.—In what two principal ways may it be operated?

A.—Either pneumatically or electrically.

1202. Q.—What is the object in building a brake that may be operated with electric current?

A.—To procure a uniform operation of brakes throughout a train of cars.

1203. Q.—In what way is this accomplished?

A.—By operating the universal valve with electric current.

1204. Q.—Does the electric operation add any braking force?

A.—No, it only produces instantaneous and simultaneous operation of brakes.

1205. Q.—Why are so many universal valves in service that are not electrically operated?

A.—Because they embody so many improvements upon triple valve operation when operated pneumatically.

1206. Q.—What are the principal improvements?

A.—Protection against undesired operation, certainty and uniformity of service operation, maximum degree of sensitiveness to release consistent with stability in operation and a separation of service and emergency functions.

1207. Q.—Why is the operating valve termed a universal valve?

A.—Through one size of valve being employed for any size or weight of car, and being built upon a unit system of construction, permits of the use, or elimination of, any feature from those of the plain triple valve up to those employed by the electro pneumatic brake.

1208. Q.—Does it operate uniformly with previous types of brakes?

A.—Yes, and among triple valves, brake operation is improved in proportion with the universal valves in the train.

(To be continued)

Car Brake Inspection.

(*Continued from page* 86, *March,* 1920.)

1101. Q.—How does holding the finger over the release slide valve sometimes stop the blow?

A.—It bottles up the emergency or rather the quick recharge pressure sufficiently to accumulate enough recharge reservoir pressure to reseat the release slide valve.

1102. Q.—How will an emergency application occur and produce this result when an emergency application is not intended?

A.—The pressure may be in all the reservoirs of the car when left standing which it is when an engine is cut off, and after a time the pressure in the brake pipe becomes depleted to a point where the brake on the car will work in quick action.

1103. Q.—Can a blow at the brake cylinder exhaust port be from any other source?

A.—Yes, from a leaky equalizing slide valve or from any body gaskets may cause the blow, hence the importance of knowing that the nuts and bolts holding the portions are securely tightened.

1104. Q.—During a service application of the brake, how can it be determined when the equalizing pistons and graduating valve move?

A.—By the short puff of air from the friction increasing cavities through the equalizing slide valve exhaust port.

1105. Q.—What causes a continued leak from the equalizing slide valve exhaust port when the brake is released?

A.—A leaky equalizing slide valve, graduating valve or a leak from the leather gasket at the release end of the release piston.

1106. Q.—What causes a leak at the emergency slide valve exhaust port with the brake released?

A.—A leaky emergency slide valve, graduating valve or from the seat of the high pressure valve.

1107. Q.—What is usually wrong if the valve does work in quick action during a service reduction?

A.—It indicates a restriction in the emergency slide valve exhaust passages, or that there is excessive friction encountered in the movement of the emergency piston and graduating valve or that the emergency piston stop spring is not standard.

1108. Q.—What caused undesired quick action with the first types of universal valves?

A.—Too large an opening leading from the brake pipe to the back of the emergency piston or emergency piston chamber which sometimes resulted in damaging the emergency piston when it was quickly moved to its release position after the valve had been in emergency position.

1109. Q.—How has this been corrected?

A.—By adding the ball check valve and a restricted port in the high pressure cap.

1110. Q.—What should be looked for if the brake should fail to apply when a service application is attempted?

A.—It must be known that the valve is cut in and the brake cylinder stop cock open, then that the air pressure is not passing the brake cylinder packing leather and that the service reservoir is fully charged.

1111. Q.—What if these parts are apparently correct?

A.—It would indicate some very serious defect of the equalizing portion, possibly a broken or stuck packing ring on the equalizing portion.

1112. Q.—What could prevent the charging of the service reservoir?

A.—The charging valve sticking shut, in which event the auxiliary reservoir pressure would flow into the service reservoir instead of the brake cylinder when the equalizing valve moved to application position.

1113. Q.—What if the failure to apply is accompanied by a heavy blow at the brake cylinder exhaust port?

A.—It would indicate that the release slide valve had not moved.

1114. Q.—What could prevent the movement?

A.—It might be due to an excessive friction in the release piston portion or to a rare combination, in fact an almost impossible combination of tight packing ring and stopped up port through the release end of the release piston.

1115. Q.—What if it should require a 9 or 10 lb. brake pipe reduction to apply the brake?

A.—It would indicate considerable friction in the equalizing portion or a very leaky equalizing piston packing ring.

1116. Q.—What could be wrong if the brake was to apply in full after a light service reduction?

A.—It might be due to brake pipe leakage or a leak from the emergency reservoir into the service reservoir past the seat of the intercepting valve or through a leak from the emergency reservoir into the auxiliary reservoir past the ball check valve in the emergency reservoir charging port.

1117. Q.—What could be wrong if the brake failed to remain applied after a service application?

A.—It might be due to brake cylinder leakage, leakage in the brake cylinder pipe or a leak at the safety valve; it might also be at the service port check valve cap nut, but such a leak could be readily noticed.

1118. Q.—What could be wrong if there were three cars coupled together and a brake application was made and one of the brakes released and shortly afterward the other two released and there was no leakage into the brake pipe from the locomotive or the yard test plant?

A.—There would be something radically wrong with the universal valve of the first car that released.

1119. Q.—What could this be?

A.—Possibly an auxiliary reservoir leak that released the brake and then a leaky quick discharge reservoir check valve which increased the brake pipe pressure for the release of the other brakes.

1120. Q.—What would be wrong if the universal valve released through the pressure escaping from the brake cylinder exhaust port and there was no leakage to be found from the auxiliary reservoir or from the service reservoir to the atmosphere, but it was noticed that there was a slight blow of air from the equalizing slide valve exhaust port?

A.—It would indicate that there was equalizing slide valve or graduating valve leakage that resulted in the release of the brake.

1121. Q.—How could this leakage result in a release of the brake?

A.—By reducing the pressure in the auxiliary reservoir below that remaining in the brake pipe in the same manner that a leaky triple valve slide valve sometimes causes a brake to be released.

1122. Q.—How is the proper way to locate any unusual defect of the universal valve?

A.—By attaching air gages to the reservoirs so that will show exactly what action of the brake is taking place.

1123. Q.—If the brake fails to release with full pressure in the brake pipe, what should first be noticed?

A.—Whether there is any escape of air from the brake cylinder exhaust port.

1124. Q.—If there is, and the brake cylinder piston does not recede into the cylinder, what would be looked for?

A.—A set hand brake, fouled brake rigging or a broken brake cylinder release spring.

1125. Q.—What should first be observed if the brake started to release but the brake cylinder exhaust was suddenly cut off?

A.—If the universal valve is being operated in graduated release the brake pipe pressure may not have increased as rapidly as the auxiliary reservoir pressure and the action of the valve would be as required by the design.

1126. Q.—What if all valves were supposed to be operating in direct release position?

A.—Brake pipe pressure may not be being maintained and the graduated release cap might have unintentionally been placed in the graduated release position.

1127. Q.—What would be wrong if 100 lbs. or more pressure was required to release the universal valve after an emergency application?

A.—It would indicate that the service port check valve or the intercepting valve seat was leaking.

1128. Q.—How would this require a higher brake pipe pressure to effect a release?

A.—Either of the parts would allow emergency reservoir pressure to flow back into the auxiliary reservoir and increase this pressure.

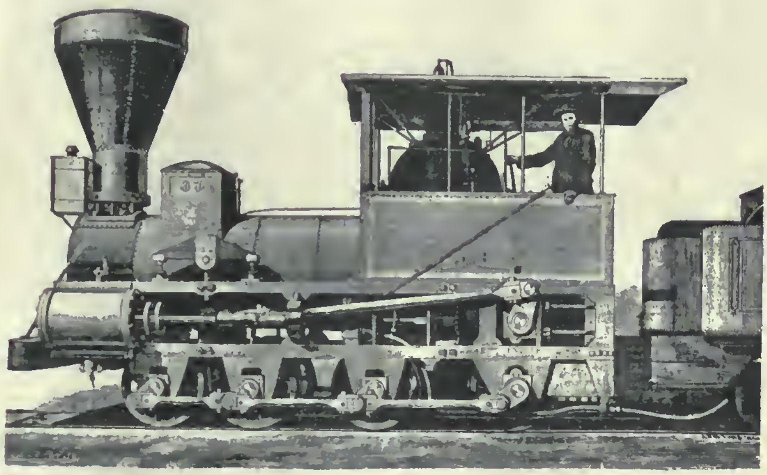
(To be continued.)

The First Horizontal Boiler Coal-Burning Locomotive

In these days of rapid improvement that have brought into use automatic stokers, oil fuel and pulverized fuel burners, it is interesting to look back at the earlier improvements, momentous in their day but now were matters of course, and almost forgotten. It may not be generally known that the first successful coal burning engines with a horizontal boiler appeared on the Baltimore & Ohio railroad between October, 1844, and December 1846, and that a substantially similar engine was built by the company in 1847. They were constructed from designs by Ross Winans, an eminent engineer of his time, and were also distinguished by being the first of the 0-8-0 type on the Baltimore & Ohio railroad, and were known as the "Mud Diggers." Their weight, in working order, was 23½ tons, and were equipped with cylinders 17 ins. by 24 ins.

cylinders and main connections were used as parts of stationary engines in the shops of the road after their road service was terminated.

Ross Winans is credited as the leader in advocating powerful locomotives, and undoubtedly had the clear conception of the economy that would result from the use of engines as large as the track would carry, and, as is well known, it is only within the present century that railroad managers have endorsed by practice the wisdom of his policy. The light track which his engines had to run upon kept down the weight, but with all the restrictions imposed by weak structures and prejudice against heavy loads, he built engines that compared fairly in efficiency with those of recent times. Mr. Winans was for a number of years employed as assistant engineer of machinery on the Baltimore & Ohio railroad, and aided in



EARLY LOCOMOTIVE "MUD DIGGER" ON THE BALTIMORE & OHIO RAILROAD.

As shown in the accompanying illustration, the main connecting rods were coupled to cranks on a shaft extending across the frames, in the rear of the firebox, and geared by spur wheels to the back driving axle. The driving wheels were 33 ins. in diameter, and the driving axles carried end cranks that were coupled by side rods. As the main and side rods moved in opposite directions, by reason of the interposed gearing, these engines presented a novel and peculiar appearance when in motion, and attracted much attention from the bewildered onlookers.

Twelve of these Winans engines were furnished between the dates referred to, and the one built by the company in 1847 was known as the "Mount Clare." All of these engines were in active service during the Civil War, and some of them continued in yard service for a number of years later, and a number of their

the construction of many of the early locomotives on that road. He also introduced new designs of valve gear which, at that time, were considered the nearest approach to an ideal cut-off ever made on locomotives.

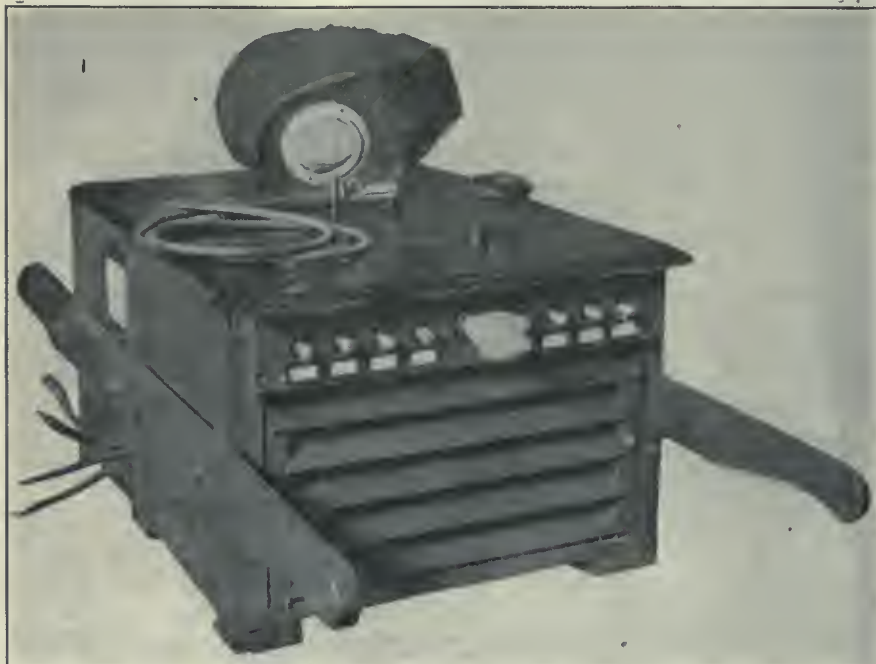
Library Census.

William F. Jacob, chairman, Library Census Committee, has issued a special call to librarians calling attention to the fact that the special library collections of the country are being enumerated. It is important that as complete a collection can be made as possible as a needed source of information. The name of the library now classified should be given, such as engineering, technical, financial, municipal or business. The data may be addressed to the Chairman, General Electric Company, Schenectady, N. Y.

Alternating Current Welding

Important Improvement in the Appliances

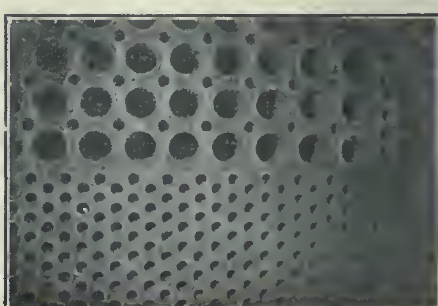
Previous to the advent of welding apparatus made by the Electric Arc Cutting and Welding Company of Newark, New Jersey, direct current had been thought necessary for arc welding, but it is becoming to be general knowledge that alternating current machines made by the above company can accomplish difficult, heavy and fast work.



PORTABLE ALTERNATING CURRENT WELDING AND CUTTING APPARATUS.

The machines consist of a special core type transformer for reducing the voltage from that of the power supply to the lower voltage of the arc, which in general runs from 15 to 55 volts. This machine is built to meet an A. C. power supply of any voltage or frequency. The line consists of two welding machines, two cutting machines and a combination cutter and welder. For light work a range of from 15 to 115 amperes is provided; for railroad welding a range of 50 to 200 amperes is provided; for heavy foundry work a combination of cutting and welding machine with range of 100 to 300 amperes is provided; for cutting rivet heads and other medium work with a graphite arc, a 600 ampere machine is made and for very heavy cutting a thousand ampere machine is made. It will be readily seen that latitude of the application of this machine is very large. All of the machines are portable and are mounted in a strong box with carrying handles. The welding machines can be picked up by two men and taken to the work (as a standard welder weighs only 265 pounds).

The machine is weatherproof and can be used outdoors as well as indoors. The openings at the ends for ventilation are protected by inclined panels and fine mesh screening. The primary leads are led out from side of box through insulated bushings and leads are securely cleated. Skids are provided to facilitate the movement of box. The secondary or welding taps in front of box, whose functions are designated by nameplates underneath each tap, are securely mounted on a slate bed plate protected by an oak fronting. These welding taps provide adjustment for various types of welding, and connection is made to these from electrode handle, or work by means of insulated plugs connected thereto. This adjustment is as quick and simple as plugging-in on a telephone switchboard. The lamp shown in center of this plugging board is for taking up inductive kick of arc on open circuiting and also is an indication that the machine is ready for work. The circular handle on top of box is a further means of obtaining fine adjustment for various types and kinds of work.



FLUE AND FIREBOX WELDING IS SAID TO BE 90 PER CENT OF RAILROAD WORK. PHOTO TAKEN BY LIGHT OF ARC.

This company also makes a helmet which is completely insulated and provides for protection to head of operator from the ultra-violet and infra-red rays, sunburning action on the skin of face and neck and from sparks in welding, especially overhead. The correct combination of colored glasses provides the protection to the eyes from tiring, and allow of the fusing action of the metal being viewed with the certainty necessary in good welding. When tipped back the helmet provides by its side pieces protection against flashes from adjacent operators. It is generally worn with a cap, peak backwards, completely protecting the hair. The front fits the chest so that it acts as an efficient protection from falling objects in shipyard and railroad work. Women operators like this helmet because of protection to the hair and because it leaves both hands free for use.

The welding handle consists of a spring grip insulated holder of an alloy not affected by the heat of the arc, and provides for the gripping of all types of electrodes at all angles without the tiring necessity of keeping pressure on either handle. A single squeeze and gravity removes the very short stub end, and a new electrode is inserted with minimum trouble and time. The current is led to the electrode through both halves of the handle equally, and ample capacity and radiation are provided so that handle does not get hot. The very extra flexible leads so necessary for wrist flexibility and absence of current torque interruptions are brazed into the handle so that they are an integral unit.

While this machine will use any type of electrode made, yet this company also puts out a coated electrode which it has developed in order to overcome the oxidation of the molten metal and the weld. Under ordinary conditions of welding, the molten metal has a greater affinity for oxygen, and oxidation may be carried on to such an extent that the weld is ruined. This is especially true in welding of heavy sections where there has been no union in the body of the weld, the outside shell sometimes successfully carrying all of the load. The coating on these electrodes mentioned consists of chemicals which attack both the oxygen and nitrogen of the air with greater chemical affinity and at a lower temperature than molten steel, which protects the steel from the air.

Cast iron is also depositable electrically as an electrode by this process.

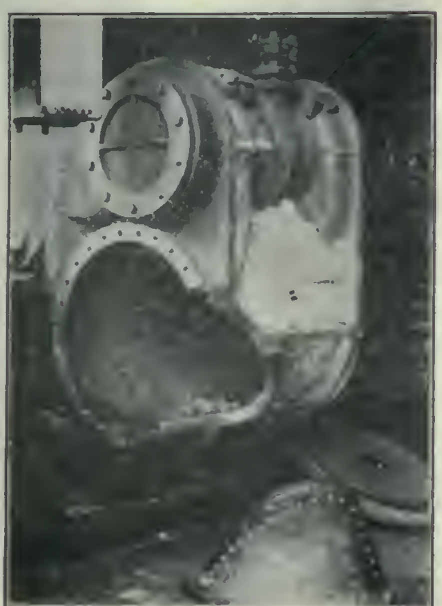
In using this electrode it will be noted that the arc is definitely located ahead of the puddle, so that a continuous weld is automatically made.

In the matter of heat control it is very desirable that the heat delivered should be held constant during the whole period of making the weld; and, it is claimed that this alternating current machine does hold the heat of the arc automatically and substantially constant for any given setting.

Different metals, electrodes, and conditions in shops require various amounts of heat, and varying temperatures, and these adjustments are obtained by an easily moved adjustment handle on our special transformer, together with taps arranged on the plugging board.

In the matter of wiring, no heavy and expensive cables are required nor does a very careful graduation of the size of the wires used have to be made because the machine is easily moveable and the heavy secondary wires are done away with.

The maintenance is claimed to be almost nothing since the apparatus has no moving parts and there seems to be no reason why it should not last indefinitely, except for accidental mechanical injury or abuse. In starting welding no brushing or chipping is necessary.



BROKEN LOCOMOTIVE CYLINDER.

The makers of the machine are strong in their advocacy of the short arc and have so arranged their machine that the length of the arc under any given condition is thus controlled and so arranged as to be in the hands of the welding foreman only; as in any weld known, with a long arc, the metal is not only oxidized and cooled in passing from the electrode to the work but there is a good chance that it will not enter the crater molten bowl where the arc is striking. We would like to again repeat, no special electrode is necessary for the use of this A. C. Machine but that we consider that the best electrode is none too good for the advance of welding as a whole.

LOCOMOTIVE CYLINDER AFTER REPAIR BY ELECTRIC WELDING.

As examples of the welding that has been done with this machine reproductions of photographs are presented showing a broken locomotive cylinder before and after welding and an exceedingly neat job of flue welding in a locomotive boiler.

The actual costs of arc welding, especially in railroad work are so comparatively low relatively to any other method that the replacement value of the part repaired is about the only value comparable, as in general the piece could be saved in no other way, for instance:

Locomotive cylinder piece welded in: cost $15, saved $1,100.

Locomotive engine frame welded in place: cost $10, saved $500.

Crack in the flue sheet welded: cost $8, saved $300.

Flues welded in the fire box end: cost $10, saved 3 years' calking.

Transmission poles welded where corroded: cost $3, saved cost of new pole.

Frogs and turnouts welded to size: cost $5, saved cost of new frog.

Cracks in truck members welded: cost $1, saved cost of new truck.

The Need of Capital.

Frank H. Fayant, assistant to the chairman of Railway Executives says that "if American capital is to continue to be devoted to the development of railroads, then the railroad business must hold out to the investor a fair return on his capital.

Railroad revenues should be such that well-located companies, honestly financed and wisely managed, can earn enough to attract all the new capital necessary for their growth. It is in the truest public interest that the railroads should be allowed to charge living rates for their service, because without such rates with which to earn a fair profit, new capital will cease to flow into railroads and the transportation machine will break down.

Throughout the country, throughout the world, there is an appeal for greater production; but production in a country like ours is absolutely dependent upon the adequacy of transportation. We cannot increase our production unless we increase our railroad facilities; we cannot increase our railroad facilities unless we attract the capital for this work; we can't attract new capital unless railroads are allowed to charge a fair price for the service they render the public."

Railroad Transportation.

The Electric Railway Journal claims that any one who will carefully analyze the conditions under which automobile-buses are operated in large cities, will find no good reason to fear the immediate abandonment of the rail. It still remains as the best means of supporting large, rapidly moving masses with the least wear and tear upon both roadways and equipment. The rail will stay with us for a long time to come, and the problem confronting us is not related to its abandonment. On the contrary, we must study its greatest possible use with respect to track design in its relation to the light-weight car."

Railway Offices Re-established.

When the railroads were taken under Federal control for operation as a national transportation system, the "Off-Line Agencies" heretofore maintained by individual roads were abandoned. This action was taken because, under nationalization, there was no longer the same competition between carriers that prevailed prior to Federal control. With the return of the roads to private management, the carriers are re-establishing the "Off-Line Agencies" for the purpose of better serving the public.

Civil Service Examinations.

Applications for the position of senior inspector of car equipment must be filed with the Civil Service Commission, Washington, D. C., prior to May 4, 1920. Applicants must show that they have had at least five years' practical experience as master mechanic, master car builder, general car foreman, or in similar service. Applicants must be between the ages of twenty-five and sixty. A reference shall be given to honorably discharged soldiers, sailors and marines. Form 1312, may be had on application to the Commission, and blanks will be furnished giving complete details as to qualifications and salary.

Novel Use for a Locomotive

It is interesting to hear of the war reminiscences from reliable sources, and to mark the ingenuity with which many difficulties were overcome. We recently learned of a novel use to which a locomotive was put in being utilized in the forging of shells.

The accompanying illustrations show in detail the methods used in producing the shells. Fig. 1 shows a steel bar cut to length. These were set up in a die and given the shape shown in Fig. 2, which was then given the cup-shape shown in Fig. 3, this intricate part of the process being carried on in the punch and die system shown in Fig. 4, which was placed on the anvil of the works hammer, three or four blows being required for the operation. The cup thus obtained had to be drawn down to the cylindrical shapes shown in Figs. 5 to 7. No machines being available for this purpose, attention was turned to some locomotives built for service on heavy grades, one of which happened to be waiting for repairs. It was moved to a position in front of a strong wall, on which the drawing down die-holder was supported. The locomotive was raised so that the wheels could turn free of the rails, and a suitable punch was fitted to the tail end of one of the pistons. A cup of the type shown in Figs. 5 to 7 was then heated to a red heat and placed in the die, when the opening of the throttle valve of the locomotive moved the piston and drove the punch forward and caused the heated cup to pass through the die. The test being eminently successful, it only remained necessary to make the temporary installation more convenient for rapid use.

The manner in which this was accomplished is shown in Fig. 8, and to a larger scale in Fig. 9. The buffer beam of the engine was replaced by a much stronger one, built up of plates and sections, and fitted, in front of the cylinder utilized for the drawing down apparatus, with the die-holder, an adjustable casing open at the side for inserting the dies one after the other. A catch against which the die butted horizontally, when it was inserted, fixed it in a suitable position so that the axis of the die was on the same vertical plane as the axis of the piston, the die being further supported on the lower part of the casing in such a way that its axes was from .118 in. to .157 in. lower than the piston axis, as shown in Fig. 9.

The cups were heated in a reverberatory furnace, erected close to the locomotive. On leaving the furnace the base of the cup was slightly cooled by immersion to a depth of .787 in. to 1.181 in. in a tank of water maintained at a constant level. At the same time, the bottom of the cup was freed of scale by means of a kind of milling cutter worked by a small portable drilling machine driven by compressed air, suspended from a jib and maintained at the right level by a counterweight. The cup-cooling was so devised as not to water-harden the metal. It imparted to it sufficient resistance to prevent the punch from driving through the base of the cup. While the cup was being made ready, the man in charge of the punching inserted the larger die after having greased it; his assistant then placed the base of the cup in the die, the throttle valve was again opened and the punch drove the cup through the die.

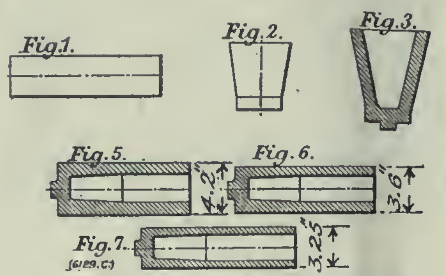


Fig. 1. Fig. 2. Fig. 3. Fig. 5. Fig. 6. Fig. 7.

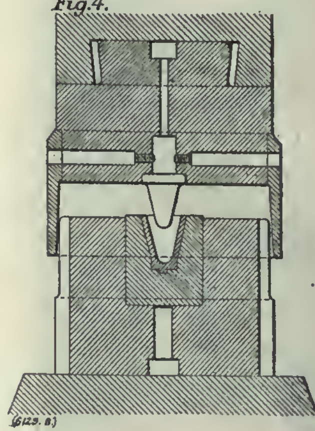


Fig. 4.

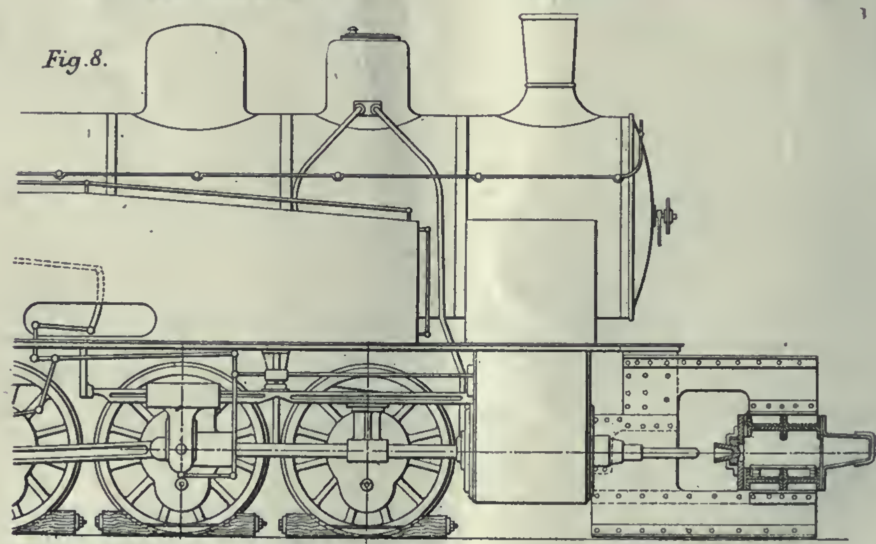


Fig. 8.

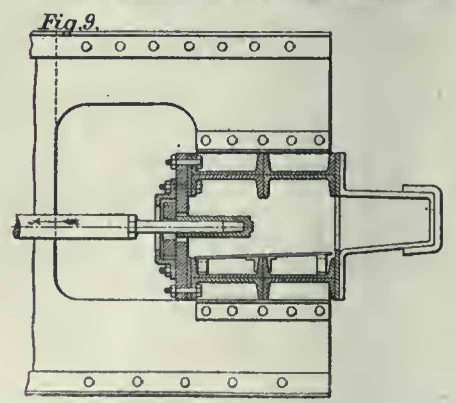


Fig. 9.

As soon as the forging had been driven through the die, the die, which in the process, had been raised and placed exactly in the axis of the cylinder, fell back in its seating and constituted a stop which helped to strip the forging from the punch as the piston traveled backwards. The forging then fell on a gutter plate, whence it was removed and replaced on the punch when the piston was in the rear position. During the time occupied in this the man in charge of the punching operations replaced the first die by a similar second one, when the drawing down continued in practically the same way, the second die acting also for stripping the forging from the punch. The third pass proceeded in a similar manner, but before this the forging was slightly reheated. During the drawing down operattons, the punch was cooled by water jets and the dies were freed of scale, cleaned, greased and placed in order for each successive operation.

Besides the throttle lever, the engine had within easy reach an air-brake valve which was used to retard the driving wheels at the end of each revolution and to stop the crank on the rear dead-center. As soon as the forging had been driven through the die, and although the throttle valve was immediately closed, the inertia of the driving wheels frequently resulted in two or three revolutions at comparatively high speed before the piston could be stopped at the back end of the travel.

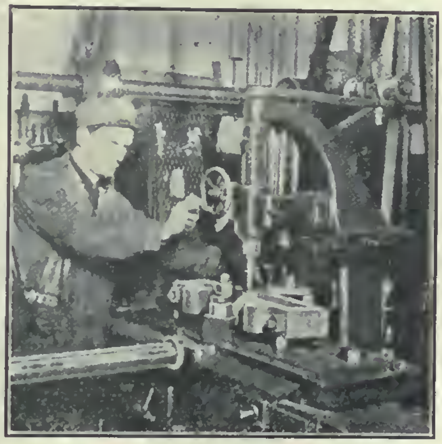
Appliances and Operations in the Grinding of Valve Gear Links

For a long period grinding of the finer parts of machines was confined chiefly to the tool-room and consisted in a large measure of accurately finishing gauges, bushings and other exact work, the work being done almost entirely on the universal grinder. A demand, however, gradually arose for finishing a large number of parts of machines by internal grinding, and this demand has called into operation many special machines that have been gradually developed for particular purposes, the internal grinding machine still being used for the general class of tool-room work.

The special internal grinding machines are designed as production tools for rapidly and accurately finishing more work in a given time than it is possible to turn out on the Universal grinder. In selecting wheels for internal grinding, carbide of silicon is recommended for cast iron and bronze, while aluminum abrasives should be used on steel, both hard and soft. As a general rule soft wheels give the best results. The reason for this is that there are comparatively few cutting points on these small wheels, and if they do not wear away rapidly, bringing new cutting points into action, the wheel glazes after a few operations. A view of one of the most popular of these later devices is shown in the accompanying illustration, the well-known Hammett link-grinding machine, adapted for finishing the radii on links used on valve gears in use on locomotives. Links are usually made of wrought iron and protected against excessive wear by case hardening, but many of the solid type of links are generally made from steel castings. Sometimes the latter are case hardened, but in other instances they are left in their soft state. It is noted that the case hardening process occasionally to some extent distends the link, in which case, if satisfactory working surfaces are desired, the errors must be carefully corrected by grinding. It was for some time the custom that links were ground on the face of a wide wheel. This practice, of course, called for the services of an expert workman familiar with the work, and even under these conditions the results were not always satisfactory.

The machine that we have referred to was especially designed to overcome the possibility of these errors. As shown in the illustration the fulcrum of the bar seen in the foreground is adjustable to accommodate links of different radii and causes the upper part of the platen to describe a curve as it traverses back and forth. The grinding wheel is carried on a vertical spindle and is fed downward as the grinding progresses. The link is lined up to the desired radius and securely strapped to the platen of the machine, although in some special cases fixtures may be provided for locating the work. In the operation of fitting up links of any kind, the first step is generally to grind the link, which is then used as a gauge in grinding the link to the correct width. This is a much easier procedure than to attempt to grind the link first and then fit the block. In fitting up the type of link known as the built-up link, the best results may be obtained by grinding the block and fillers at one operation and the other members afterwards. In assembling, the clearance to allow the block to slide is obtained by means of paper shims or links placed between the fillers and the adjacent members.

As is well known, links wear quite rapidly, especially those used in connection with the shifting or Stephenson link.



HAMMETT LINK-GRINDING MACHINE.

This is due principally to the slip of the block caused, among other things, by offsetting the saddle pin to secure the desired cut-off motion so that the points of cut-off will be equal, or nearly so, at each of the forward or backward strokes of the piston. Built-up links can be readily reground and new blocks fitted, but with solid links the only thing to do is to grind them until the radii are trued up and then fit new blocks into the link.

In regard to the operation of link grinding, it is simple after the link has been correctly located on the platen of the machine. The depth of cut should be comparatively light, as this work is done dry and the wheel should be fed down by means of the automatic feed. The wheels generally used are known as from 30 to 40 grits. As already stated when the links are of steel, an aluminum abrasive should be used.

In conclusion it may be added that while the operation of the machine is simple and readily within the reach of any intelligent mechanic, it is found to be advantageous that specially trained mechanics on this branch of shop operations are more reliable than leaving the job to the haphazard choice ,of allowing inexperienced mechanics to conduct the operation. Of course, even the best mechanics must get an opportunity before perfection can be expected, but the correct adjustment of the link upon the platen does not come by chance, but by a careful observation of the results of repeated trial. And it need hardly be stated that any error in regard to leaving a block loose in a certain portion of the link is one of the causes, if not the chief cause, of the distentions incident to the strenuous operation of the valve gear when in operation.

Transportation Facilities in Trinidad.

The Trinidad Government Railway has altogether 115½ miles of railway open for traffic. It also has three steamers, two of them used for traffic between Port of Spain and the small islands in the Gulf of Paria, and the other for traffic between San Fernando and Brighton at the asphalt lake and the small towns on the Cedros Peninsula at the extreme southwestern end of Trinidad. The railway is not extended along the coast south of San Fernando. There is a public demand for an extension of the Government railway to the east and north coasts of the island, together with a fast daily steamship service to Tobago, about 30 miles northeast of Trinidad.

Railway Supplies in Argentina.

In spite of the tendency of the railroads in Argentina to favor British products, considerable purchases have been made of American supplies, and it is by no means impossible to open business in that country. It has been found, however, that little can be done by correspondence, the chief enigneers residing in England, and many of the local purchasing agents are instructed to purchase equipment from specimens furnished from Great Britain. Certain American export houses who handle railway materials have London offices and are in a position to represent the goods they handle to the British officials of the South American railways.

Mandrels.

In general practice, mandrels do not require as high a percentage of carbon as cutting tools. Small sized mandrels give good results when made from steel of from 1.00 to 1.10 carbon. Larger sizes of mandrels are better when made of steel containing from .80 to 1.00 per cent carbon.

Electrical Department

The Production and Use of Porcelain Insulators—Interesting Railroad Electrification Facts

Porcelain Insulators.

Electricity flowing in the wires must be insulated from ground. When the voltages are low, a rubber covering over the wire is sufficient, and by making the rubber wall thicker higher voltages can be carried. Insulation on a wire is expensive and when the wire is carried across country on poles it is not needed. Only insulation at the points of support is necessary, and the common practice now is to run bare wire and to fasten this wire at the point of supports to insulators which, for high voltage work, are made of porcelain. It is a common sight to see wires run on small glass insulators. The voltage is low, however, and this type of insulator is only used extensively on telephone and telegraph circuits.

The transmission of electric power has developed rapidly. The voltage of transmission has increased rapidly from say 40,000 volts to 150,000 volts during the past few years, and it has been necessary to develop the porcelain insulator to keep up with this growth.

The construction and design of the insulator is interesting. The production of electrical porcelain is similar to the manufacture of ordinary dishware. The ingredients are similar, and the same general methods in the manufacture are employed.

Clay ware in general may be divided into two classes. In the one class, the ware is made entirely of either one clay or of a combination of clays. In the other class, the ware is not, strictly speaking, made from a clay, but is made from paste that contains clay as an ingredient, in combination with other ingredients, such as feldspar and flint. Very ancient pottery comes under the first class. Porcelains, including electrical porcelain, belong in the second class.

Of the three main factors, namely, flint, feldspar and clay, there are different kinds to choose from. Take flint for instance; there is flint from the pebble; flint from quartzite, or just plain pure sand, ground fine. In the case of flint, the porcelain maker wants a finely ground or powdered material which is clean and pure. The same statement applies to feldspar, except other tests must be made. A chemical analysis is frequently of service in determining the quality of the material.

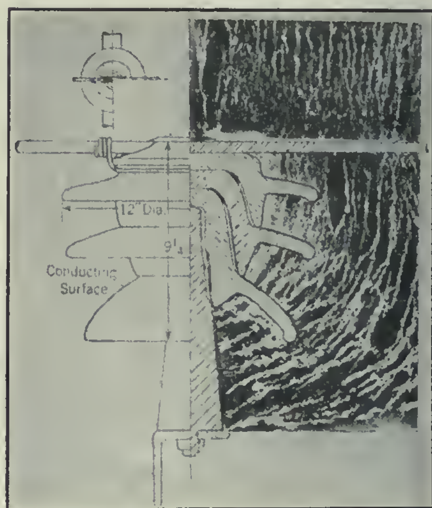


FIG. 2. THE DIELECTRIC FIELD OF A "FARADOID" INSULATOR.

There is also a wide variation of clays. No two are quite alike.

The batches are usually weighed in lots of about one ton. The clays are weighed first and thrown into the "blunger" and then the other ingredients are added. The blungers are great churns which beat and mix all the ingredients with water, so that after several hours the mass is reduced to a thick, creamy consistency termed "slip." The slip is allowed to run over a screen which is kept shaking or revolving by mechanical means. The screen catches the dirt and impurities. The slip goes into a cistern, where it is kept in motion to prevent the heavier ingredients, the flint and feldspar, from settling out.

From the cistern the slip is pumped into presses. The water is strained out to a certain degree, leaving a cake. The cakes are transferred to a cellar, stored in a compact mass, and left to "age."

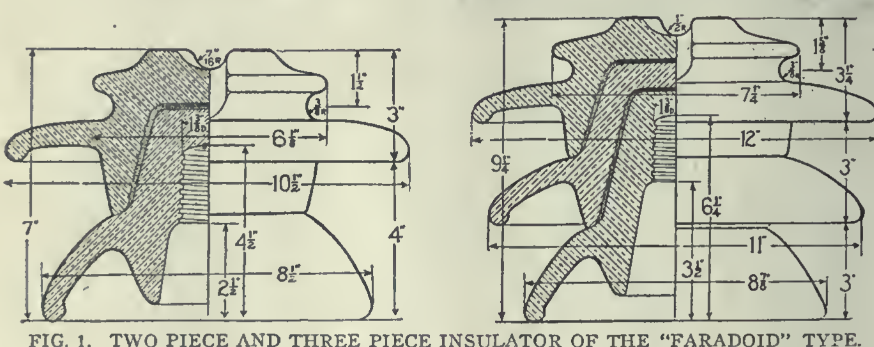


FIG. 1. TWO PIECE AND THREE PIECE INSULATOR OF THE "FARADOID" TYPE.

After a sufficient amount of aging has taken place the cakes are shaped into the form desired. These forms are then allowed to dry, which may take only a few days or as many weeks, depending on design. When dried, the ware is dipped in the glaze. Glazing comprises a thin coat of glass made up of the same ingredients as the body, and with materials added which will cause the mixture to melt to a glass long before the body itself. Generally a coloring oxide is added to produce the desired color. If the insulator was not glazed the surface would be slightly rough and dirt would collect.

After glazing the insulator is ready for the kiln, where firing generally covers a period of several days.

There is a wide variation in the shape and sizes of insulators. As the voltage on the wire increases the insulator design becomes more and more important. A wire carrying a very high voltage is surrounded by an electrostatic field, and the insulator design can be such that this field is distributed evenly over the surface. Older types of insulators did not accomplish this, with the result that the insulators break easily when a flash occurs over the insulator.

The following items are the main causes for the failure of insulators:

1. Improper distribution of the dielectric field.
2. Improper distribution of surface leakage.
3. Porosity.
4. Mechanical breakage.
   a. From handling.
   b. Mischievous shooting.
   c. Insufficient strength at support.
   d. Brittle material.
5. Lightning.
6. Birds and animals short-circuiting line.
7. Unequal expansion of metal, cement and porcelain.
8. Internal stresses in material.
9. Defective batches.

The production of one-piece insulators for high voltage service, although possible, would be costly. The separation of the unit into parts that are cemented together, more uniformly divides and distributes the stress of the dielectric if the unit is properly designed. It also decreases the probability of complete failure.

The Westinghouse company has considered all of these points of failure and theoretical designs and have brought out a design known as the "Faradoid" type.

There are of course many designs, but two general designs are shown by Fig. 1.

The dielectric filled form for this type of insulator is shown by Fig. 2. The dielectric field was determined by the following procedure: The insulator was fastened rigidly in a position such that the plane of the field to be determined extended horizontally. A piece of fullerboard (a sheet of insulation) was fitted over the half section. Finely divided asbestos was sprinkled evenly onto the fullerboard and the voltage applied. A field is formed immediately, and by tapping the fullerboard the asbestos particles arrange themselves along the lines of force. Permanent records can be obtained by placing a sheet of photographic printing paper over the fullerboard, obtaining the field, and exposing the paper after the particles had become arranged.

FIG. 3. FLASHOVER ON OLDEN TYPE INSULATOR.

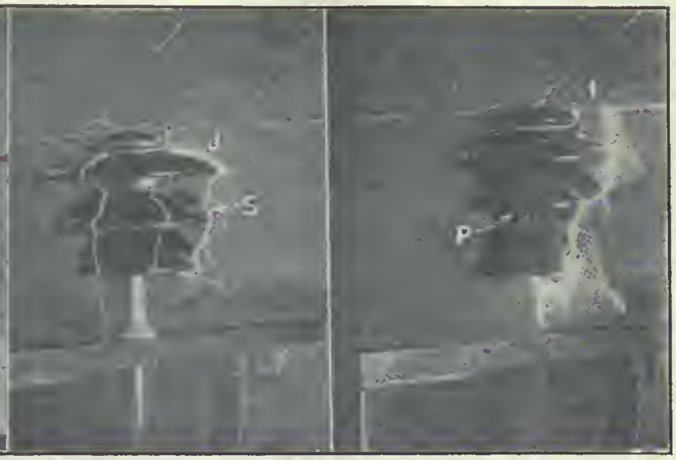


FIG. 4. FLASHOVER "FARADOID" TYPE INSULATOR.

Flashover on most of the older insulators is caused by what is known as the corona formation at the line and at the edges of the cement joints. As the voltage applied to the insulator is increased, the area of the corona formation increases and static streamers gradually spread over the surfaces of the insulator. The static streamers increase in length until the air insulation finally fails and flashover follows.

In the "Faradoid" type there are no static streamers from the edges between shells. The corona formation at the wire builds up until flashover occurs by breaking down an air path between the line and the pin or cross arm. Fig. 3 shows the streamers on an older type of insulator, and Fig. 4 the flashover at one of the "Faradoid" type. The flashover passing over the insulator, as in the older type, causes breakage, a sample of which is shown by Fig. 5. In the Faradoid type the absence of streamers from the porcelain surfaces cause the arc to keep clear of the insulator.

FIG. 5. FLASHOVER OLDER TYPE INSULATOR RESULTING IN BROKEN SHEDS OR PETTICOATS.

A Few Interesting Railroad Electrification Facts.

The Chicago, Milwaukee and St. Paul Railroad is the first large western road to take a decided stand on electrification and to go into it on a large and extensive scale. In the East the New Haven had electrified on a scale that at the time seemed extensive, and with wide laid plans for a great big electrified system.

In the spring of 1917 the Cincinnati & St. Paul had 440 miles under electric operation. This electrified portion of the road crosses the Belt Mountains, where an elevation of 5,768 feet is reached. The Rocky Mountains and the Bitter Root Mountains are also crossed at elevations of 6,350 ft. and 4,200 ft., respectively.

The road at once replaced all of the steam engines by electric locomotives, and by this substitution eliminated one division point. From the very outset electric operation was a great success. Where formerly it was necessary to employ a large number of pusher or helper locomotives to help handle the passenger and freight trains over the mountain grades, these have been nearly eliminated. The electric locomotive has practically eliminated the mountain grades. Not only are the grades practically eliminated, due to the electric locomotive characteristics, but the trains are handled uniformly and with very few failures. The question of dispatching is simplified and the trains, due to electric operation, are moved more rapidly and more economically.

We have heard a great deal about regenerative braking. The arrangement for the different systems have been described in the columns of this paper. On the Cincinnati-St. Paul, regeneration has been carried on a large scale, and has proved most successful and economical. We mentioned above that the electric locomotive had practically eliminated the mountain grades. This is as true in the descending as in the ascending, for by means of regeneration the heavy transcontinental passenger trains and the maximum tonnage freight trains are moved down the long heavy grades uniformly without the use of the air brakes.

Economies are the result of electrification. There is the elimination of water and coal stations, the elimination of cinder pits and of round house forces at intermediate division points; the quick inspection and ready turning back into service of the electric locomotive, all mean economy. Regeneration saves the brake shoes and wheels, and not only that, but eliminates the necessity due to the heavy grades, of stopping to cool the brake shoes and wheels. The stored energy of the train, due to gravity, must be dissipated by the friction of the brake shoes on the wheels. A 2,500-ton train running at 17 miles per hour down a 2 per cent grade has energy which approximates 3,500 k.w., or 4,700 h.p. Hence, at times, red hot brake shoes and other serious damage results.

The temperature in the west during the winter reaches very low figures and at times for long periods may be many degrees below zero. The very low temperature has a very decided effect on the steam locomotive and at times it is almost impossible to move trains by steam. Concrete cases exist on the C. & St. P. where heavy freight trains were standing on the main track, stalled, due to cold weather. The electric locomotive cleared the track without difficulty. Here was a practical demonstration that, while the steam locomotive is at its lowest efficiency in cold weather, the electric locomotive is at its highest point of efficiency.

The handling of the electric locomotive appeals to the operating man. It is ready for operation at a moment's notice. In switching service, the handling is so much easier, in that there is no heavy reversing gear to throw, but only a small reversing lever, and it does not necessitate the operator changing his position at the window.

Westinghouse Air Brake Company.

The annual meeting of the stockholders of the Westinghouse Air Brake Company was held at Wilmerding, Pa., on April 13th, 1920. The report reflected the united operations of the following companies: The Westinghouse Air Brake Company, Westinghouse Traction Brake Company, Westinghouse Friction Draft Gear Company, Westinghouse Pacific Coast Brake Company, Westinghouse Air Brake Home Building Company, Union Switch & Signal Company, Union Signal Construction Company, The American Brake Company, National Brake & Electric Company, National Steel Foundries, Milwaukee Locomotive Manufacturing Company, Safety Car Devices Company, Locomotive Stoker Company.

All contracts with the Government have been completed and settlements made. The orders booked since the return of the railroads to private ownership indicate a volume of business equal to, if not exceeding, that of previous years. The foreign companies are also in a very satisfactory condition, the Westinghouse Brake Company of London, the Compagnie des Freins Westinghouse, of Paris, and the Italian Company, all show increased earnings over previous years. The German Company at Hanover is operating in a limited way, while on account of the conditions in Russia, no definite report has been received for the company in that country. The Canadian Westinghouse Company has paid 8 per cent or $8 per share. The assets of all companies, including patents, are estimated at over fifty-two million dollars. The usual quarterly dividend of $1.75 per share has been declared.

New Name in Oxy-Acetylene Field.

The Oxweld Acetylene Company of Newark, N. J., and Chicago, Ill., has recently extended its manufacture of oxy-acetylene apparatus and equipment to include "Eveready" welding and cutting outfits. The apparatus is not new, except in certain refinements of design, having been previously well known under the name of "Prest-O-Lite." The apparatus is designed for being used exclusively with compressed acetylene in cylinders, and provides the welder and cutter with a compact and portable outfit, and will be found to be economical and ever ready.

Transportation Council.

Under the auspices of the Merchants' Association of Greater New York a council was held at the Hotel Astor on April 14, 1920. William C. Beed, chairman of the Members' Council, presided. The principal speakers were A. H. Smith, president of the New York Central, and George C. Taylor, president of the Railway Express Company. Great inconveniences and serious losses resulted from the effect of the interruption of transportation when the railroads were diverted from industrial to war uses, even though the Government sought by a system of preferences to serve all interests. A united effort is being made in endeavoring to set the affairs of the railroads in order, and many railroad men, especially those who have not been on the inside of railroad operation during Government control, are still uncertain upon the scope and effect of the changes made by the new law.

Merger of Noted Engineering and Construction Companies.

The plan for the merger of Westinghouse, Church, Kerr & Co., and Dwight P. Robinson & Co., has been declared operative, and Mr. Robinson has been elected president, pending completion of the merger. General Guy E. Tripp, now chairman of the board of Westinghouse, Church, Kerr & Co., retains that position pending completion. The new company starts business under very favorable conditions. The Robinson company has been eminently successful in power plant construction, and the Westinghouse, Church, Kerr & Co. has been in the front rank of railroad and industrial construction work. The new company will retain the personnel of both organizations, and will become one of the largest and most successful in the construction and engineering business.

Cheap Transportation.

C. A. Prouty, an eminent authority on transportation, says that the cut of transportation has ordinarily increased less than any other considerable item of cost entering into a manufacturing total. Reckoned in per cent of the value of the things transported, the freight rate is today lower upon most articles than it has been for the last twenty-five years. While passenger fares upon the railroads have been advanced from time to time, there never was a period when so many people traveled and paid their fares with such apparent ease as today.

Carborundum.

It is not infrequently stated that carborundum will not grind steel economically, but this statement is erroneous. It is the hardest and sharpest of all abrasives, both natural and artificial, and shows high efficiency on steel grinding. There are, of course, other abrasives used in grinding wheels that are very efficient in their operation.

Mechanical Conventions.

The committees of Section III—Mechanical report that arrangements are being perfected in regard to the details of the Atlantic City convention. Matters pertaining to locomotives and their appliances will be presented and discussed on Wednesday, Thursday and Friday, June 9, 10 and 11, and matters relating to cars on Monday, Tuesday and Wednesday, June 14, 15 and 16. The Railway Supply Manufacturers' Association has been compelled to extend the space for exhibits and the balcony over the main building on Young's Pier will be utilized for the purpose for the first time during the convention at Atlantic City.

National Safety Council.

The executive committee of the steam railroad section of the National Safety Council, at a recent meeting held at Chicago, planned the work of that section for 1920. Improvements were planned in the section's bulletin service, the program for the 1920 Safety Congress was discussed and Dr. Payne's plan for safety education was endorsed.

Items of Personal Interest

George T. Depue has been appointed mechanical superintendent of the Chicago region of the Erie.

Frank J. Dailey has been appointed assistant master mechanic of the Erie, with office at Dunmore, Pa.

F. N. Jenkins has been appointed locomotive foreman on the Canadian Pacific, with office at Brownville Junction, Me.

A. R. Teague has been appointed master mechanic of the Mobile & Ohio, with office at Whistler, Ala., succeeding G. L. Lambeth, promoted.

N. C. Ross, master car builder of the Copper Range, has been appointed master mechanic at Houghton, Mich., succeeding N. M. Barker.

C. G. Slagel has been appointed acting superintendent of motive power of the Cincinnati, Indianapolis & Western, with offices at Indianapolis, Ind.

Albert J. Davis, shop superintendent on the Erie, at Galion, Ohio, has been appointed master mechanic at Jersey City, N. J., succeeding F. H. Murray.

Fred L. Voerge has been appointed assistant master mechanic of the Montana division of the Northern Pacific, with headquarters at Livingston, Mont.

Frederick H. Murray, master mechanic of the Erie at Jersey City, N. J., has been appointed shop superintendent at Susquehanna, Pa., succeeding G. T. Depue, promoted.

William Kelly, assistant superintendent of motive power of the Great Northern, has been appointed general superintendent of motive power, with headquarters at St. Paul, Minn.

M. J. Flanigan, master mechanic of the Great Northern at Everett, Wash., has been appointed general master mechanic of the Eastern district, with office at St. Paul, Minn.

H. H. Maxfield, works manager of the Pennsylvania, at Altoona, Pa., has been appointed regional superintendent of motive power of the Central region, with headquarters at Pittsburgh, Pa.

W. F. Kuhlke, master mechanic of the Charleston & Western Carolina, with headquarters at Augusta, Ga., has been appointed superintendent of motive power, with headquarters at Augusta.

J. A. Wright, general foreman of the Chicago, Milwaukee & St. Paul, has been appointed division master mechanic at Tacoma, Wash., succeeding C. E. Cessford, transferred to Bellingham, Wash.

C. E. Peck, assistant superintendent of motive power of the Oregon-Washington Railroad & Navigation Company, has been appointed superintendent of motive power and machinery, succeeding J. F. Graham, deceased.

A. J. Devlin, master mechanic of the Western division of the St. Louis-San Francisco, at Enid, Okla., has been appointed shop superintendent of the North shops at Springfield, Mo., succeeding J. E. Henshaw, transferred.

B. J. Peasley, superintendent of motive power of the Vicksburg, Shreveport & Pacific, at Monroe, La., has been appointed superintendent of motive power of the St. Louis Southwestern, with headquarters at Tyler, Tex.

J. J. Tatum, general supervisor of car repairs for the United States Railroad Administration, has returned to the service of the Baltimore & Ohio, as superintendent of the car department, with headquarters at Baltimore, Md.

J. J. Dowling, general master mechanic of the Eastern district of the Great Northern, with office at St. Paul, Minn., has been appointed superintendent of motive power of the lines West, with headquarters at Spokane, Wash.

Robert Collett, assistant manager of the Fuel conservation section of the Railroad Administration, during the period of Federal control, has been appointed superintendent of fuel, and locomotive performance, on the New York Central.

Amos C. Davis, master mechanic of the Maryland division of the Pennsylvania, with headquarters at Wilmington, Del., has been appointed superintendent of motive power of the Southern division; Eastern region of the same road.

J. E. Ennis, corporate assistant engineer of rolling stock of the New York Central Lines, with headquarters at New York, has been appointed engineer of equipment claims, the former corporate title of engineer of rolling stock having been abolished.

H. A. Wanberg has been appointed traveling boiler inspetcor on the Chicago & Milwaukee, with jurisdiction on the lines east of the Missouri river, and Frank Loetz has been appointed master boiler maker at Milwaukee, Wis., succeeding Mr. Wanberg.

W. J. Foley, assistant master mechanic of the Northern division of the St. Louis-San Francisco at Monett, Mo., has been appointed master mechanic at Enid, Okla., succeeding A. J. Devlin, and F. G. Fisher, has been appointed master mechanic at Monett, succeeding Mr. Foley.

George H. Emerson, formerly general manager of the Great Northern, and since 1917 in charge of the Russian Railway Corps, with the rank of Colonel, has been appointed chief of motive power and equipment of the Baltimore & Ohio, with headquarters at Baltimore, Md.

Edwin B. De Vilbiss has been appointed superintendent of motive power of the Eastern Ohio division of the Pennsylvania, Central region. Mr. De Vilbiss is a graduate of Purdue University, and has occupied many positions in the mechanical department of the Pennsylvania during the last twelve years.

G. H. Langton, shop superintendent of the Virginian at Princeton, Va., has been appointed master mechanic, with the same headquarters, and the title of shop superintendent has been abolished. B. E. Nevins has been appointed master mechanic at Victoria, and H. L. Getty has been appointed master mehcanic at Roanoke, Va.

Henry Yoerg, assistant superintendent of motive power of the Great Northern, has been appointed superintendent of motive power of the lines east, with headquarters at St. Paul, Minn. Mr. Yoerg is a graduate of the Massachusetts Institute of Technology, and entered railway service in the Great Northern as a draftsman in 1897, and has had a wide experience as mechanical engineer in machine and car shop work.

Frank H. Hardin, assistant to the Federal manager of the New York Central, has been appointed chief engineer of motive power and rolling stock, with headquarters at New York. Mr. Hardin is a graduate of the Georgia School of Technology, and latterly took a post graduate course at Columbia University. He entered railway service as a special apprentice at the West Albany shops of the New York Central in 1909, and has remained with that company ever since, filling various positions until his appointment in the office of the Federal manager.

W. C. A. Henry, superintendent of motive power of the Southwest systems of the Pennsylvania Lines West, headquarters at Columbus, Ohio, has been appointed general superintendent of motive power of the Southwestern region of the same road, with headquarters at St. Louis, Mo. Mr. Henry was educated at the Brooklyn Polytechnic Institute, and entered railroad service as a special apprentice in the Altoona shops of the Pennsylvania in 1891, and has occupied many positions during a period of nearly thirty years in which he has been in the service of the Pennsylvania.

James A. Anderson has been appointed shop superintendent of the Chicago, Milwaukee & St. Paul, at Milwaukee, Wis., succeeding A. W. Lucas, resigned. Mr. Anderson is a graduate of the Maryland State College, and served a special apprenticeship in the Mt. Clair shops of the Baltimore & Ohio, and was appointed material inspector in the test bureau of that road in 1907, since when his promotion has been rapid, filling many positions in the mechanical department, his latest position being that of assistant superintendent in charge of the locomotive department of the company's shops at Pittsburgh, Pa.

Thomas W. Demarest has been appointed general superintendent of motive power of the Northwestern region of the Pennsylvania, with headquarters at Chicago, Ill. Mr. Demarest is a graduate of the Stevens Institute of Technotogy at Hoboken, N. J. He entered railroad service on the Pittsburgh, Cincinnati, Chicago & St. Louis, where he was advanced to the position of superintendent of motive power in 1900. In 1903 he was appointed superintendent of motive power of the Northwest system of the Pennsylvania Lines West, which position he held at the time of his appointment, as above noted.

J. M. Henry, assistant general superintendent of motive power of the Pennsylvania at Altoona, Pa., has been appointed general superintendent of motive power of the Eastern region of the same road, with headquarters at Philadelphia, Pa. Mr. Henry is a graduate of Purdue University, and entered railway service as a special apprentice in the office of the assistant engineer of motive power at Altoona in 1900, and was promoted rapidly to various positions, particularly in the mechanical department. In 1913 he was appointed superintendent of motive power of the Western Pennsylvania division, and in 1917 to the position as noted above at Altoona.

Charles James, mechanical superintendent of the Erie, Lines West, with headquarters at Youngstown, Ohio, has been appointed mechanical superintendent of the Hornell region of the same road, with headquarters at Hornell, N. Y. Mr. James entered railroad service as machinist's apprentice at Elkart, Ind., in 1880, and in 1890 was appointed roundhouse and shop foreman of the Erie at Huntington, Ind. After various promotions he was appointed master mechanic of the Rochester division at Avon, N. Y., and was transferred to a similar position at Galion, Ohio, and latterly to the New York division. In 1914 he was appointed mechanical superintendent at Youngstown as noted above.

P. F. Smith, Jr., has been appointed works manager of the Pennsylvania at Altoona, Pa. Mr. Smith graduated from the Warralls Technical Academy in 1887, and entered railroad service as an apprentice in the Altoona shops of the Pennsylvania, and after various minor promotions in the company's service was appointed master mechanic of the Crestline, Ohio shops, in 1896. In 1900 he was appointed master mechanic on the Pittsburgh, Cincinnati, Chicago & St. Louis, and in 1912 returned to the Pennsylvania as superintendent of motive power of the Central system, Pennsylvania Lines West, and in 1917 was appointed general superintendent of motive power of the Lines West, which position he held at the time of his appointment to the new position of works manager at Altoona.

Walter K. Lovekin, for the past two years assistant to the president of the Locomotive Feed Water Heater company, has been elected vice-president and treasurer of the company. Mr. Lovekin is a graduate of Princeton University, and was engaged for several years in municipal research work in Philadelphia, and latterly with the R. J. Crozier Company, as a salesman handling railway and mining supplies. In 1916, Mr. Lovekin entered the service of the Locomotive Feed Water Heater Company, and has been chiefly engaged on the Marine field, involving the manufacture and delivery of feed water heaters, evaporaters, boiler feed pumps, distillers and oil coolers for more than 550 ships built for the United States Emergency Fleet Corporation. Mr. Lovekin will continue in charge of the marine department, and will be in charge of all sales and sales matters for the company in addition to his duties as treasurer.

W. O. Thompson, superintendent of rolling stock of the New York Central lines west of Buffalo, N. Y., with headquarters at Cleveland, Ohio, has been appointed general superintendent of rolling stock of the entire system, with headquarters at Buffalo, N. Y.

Mr. Thompson is from Clayton, Mich., and was educated at the high school, Ft. Wayne, Ind. He entered railway service at an early age, and from 1877 to 1893 he filled many positions, chiefly on the Michigan railroads. In the latter year he was appointed general foreman and engine dispatcher on the Lake Shore & Michigan Southern. From 1899 to 1901 he was engaged in the railway supply business. He was also connected for some time with the International Correspondence Schools, and from 1902 to 1907 was division superintendent of motive power on the New York Central, and in the latter year appointed master car builder of the same road. In 1915 he was appointed superintendent of the rolling stock of the New York Central Lines West of Buffalo as above noted.

In the organization of the Traveling Engineers' Association, he was particularly active, and was elected secretary of that association at the first convention held in Chicago in 1893, and has ably filled the office ever since. In the work of establishing the association he was assisted by Angus Sinclair, John A. Hill and C. B. Conger, the preliminary meeting being held in the offices of Messrs. Sinclair and Hill, and it is owing largely to Mr. Thompson's continued intelligent activity that the association has maintained its commanding influence among the organized mechanical bodies.

OBITUARY

James J. Flannery

James J. Flannery, for many years president of the American Vanadium Company, and also executive head of the Flannery Bolt Company, Pittsburgh, Pa., died on March 6, at the age of 66 years. Mr. Flannery was also president of the Meadowlands Coal Company and the Montour & Lake Erie Coal Company. Gifted with rare executive ability and energy, Mr. Flannery, in company with his younger brother, has made a distinctive place for himself in the annals of the steel industry. While the remarkable qualities of vanadium were first drawn to the attention of the scientific world by Prof. Arnold of Sheffield, England, the Flannery brothers must be credited with its popular introduction, particularly to railroad work, in locomotive frames and other castings, small percentages of vanadium in conjunction with other alloys showing a remarkable increase in elastic limit, with an increase also in ductility.

Joseph M. Flannery

Joseph M. Flannery, president of the Standard Chemical Company, and, together with his brother, James J. Flannery, an organizer of the Flannery Bolt Company, and American Vanadium Company, died on February 18, after a lingering illness, in his fifty-third year. In the manufacture of staybolts and other products, the two brothers made many notable improvements and were the first to introduce in sufficient quantities vanadium, which had been discovered in some of the lead ores in Mexico, and later rediscovered in small quantities in Sweden, from whence it obtained its name, from Vanadis, the earth mother, the principal goddess of Swedish mythology. The brothers Flannery, quick to observe the value of vanadium, obtained control of a vast deposit in the Andes of Peru, and successfully introduced its application in the manufacture of alloy steel. The Vanadium Company, which they established, controlled nearly all of the marketable supply, and only a short time ago sold out their holdings to the Vanadium Corporation of America, of which Charles M. Schwab and J. Leonard Repogle have now the controlling management.

BOOKS, BULLETINS, ETC.

The Model T Ford Car: Its Construction, Operation and Repair. By Victor M. Page, M.E. The Norman W. Henley Publishing Co., 2 West 45th Street, New York. 410 pages, 153 engravings and folding plates.

The popularity of the Ford car, the Fordson farm tractor, the F. A. starting and lighting system, and the Worm Drive 1-ton truck has induced the author and publishers to bring out a revised and enlarged edition of this work, with all of the new Ford improvements described. The book is divided into eight chapters and is especially written for drivers and owners of Ford cars by an eminent authority in automobile engineering distinguished for clearness of style. Not only is the construction fully described, but the running and repairing is made equally clear, leaving nothing for guess work. The illustrations have been specially made for the work, and it is altogether the best and most complete work that we have seen on the subject of automobile or tractors. The paper, presswork and binding are excellent.

Graphite.

The organ of the Joseph Dixon Crucible Company, Jersey City, N. J., comes out in a new form. Instead of twelve by nine, it is six by nine, and double the number of pages. The improvement in point of elegance is marked. As to the paper and presswork, they are like the Dixon pencils—nothing could be finer. Intellectually it is also brighter. The merits of the company's products are, of course, the backbone of the material, but always backed by proofs supplemented by fine illustrations. In the March number a reproduction of the Dixon Exhibits at the Hardware Convention is supremely artistic. Copies may be had on application to the company.

Lubrication.

The Texas Company's organ devoted to the selection and use of lubricants for March contains an interesting and instructive article on Refrigerating Machinery lubrication. We are reminded that this is the season of the year when operators of cold storage plants are overhauling their machines and installing new equipment, getting ready for the hot weather. We are also reminded that the development of high-speed tools has introduced conditions which absolutely require the constant application of a cooling and lubricating medium to both the tool and the work, and today all up-to-date plants are, or should be, equipped with systems for their circulation and purification.

Fuel Saving Chart.

The International Correspondence Schools, Scranton, Pa.—Railroad service division, has issued Fuel Saving Chart, No. 2, showing methods of testing for valves and cylinder packing blows. In the pressing necessity for fuel saving the chart is peculiarly timely and highly instructive. The chart shows the piston and piston valve in six different positions, with letterpress data in regard to the exact location of blows. A careful study of the chart would preclude the possibility of guesswork which is too common, causing serious delays in investigations that frequently fail to locate the defect. The drawings are excellent, showing the cylinder and steam chest, and all appliances, with the live steam in dark orange, and the exhaust steam in light orange, and is altogether a valuable addition to the educational works of the popular institution.

Simplex Track Jacks.

Templeton, Kenly & Co., Chicago, Ill., sole manufacturers of Simplex Jacks, has issued a special bulletin calling attention to the recent improvements in track jacks. As is well known the source of nearly all track jack failures arose from loose or bent fulcrum pins. The Simplex latest designs are built with but one-inch steel fulcrum trunnions formed integral with the lever socket and rotating in hardened steel bushings. These one-inch trunnions have four times the strength of the half-inch fulcrum pins, and practically twice the strength of the three-quarter-inch fulcrum pin in trunnion. The parts are also interchangeable — specifically the same forging dies and patterns produce the pawls, trips, sockets and trunnions, so they are uniform in strength, size, fit, finish and cost. They can be furnished at less cost than when fitted with round sockets and wooden poles.

Reversing Planer Motors.

Bulletin No. 48029, issued by the General Electric Company, Schenectady, N. Y., furnishes complete details of the company's latest design of the R F. Reversing Planer Motor. The fine illustrations show the story and simple construction of both motor and control. The control is such that from 250 to 500 revolutions per minute is used for the cutting direction, and from 500 to 1,000 revolutions for the return. The energy stored in the rotating member is a minimum, hence quick acceleration or deceleration is obtained. The marked success of the equipment depends upon this factor, especially on close or short-stroke work. The loss of time by the old system of belt drives is shown by a series of records, taken on a graphic recording ammeter, and the comparison as shown by the use of the reversing motor is very marked. The best method of attaching reversing motors and control to old planers is also described, and the bulletin is altogether of real value.

Accident Bulletin, No. 72.

Statistics of collisions, derailments and other accidents resulting in injury to persons, equipment or roadbed, arising from the operation of railways used in interstate commerce, occurring during the months of April, May and June, 1919, have been issued, and the United States Railroad Administration must be credited with advancing the issuance of the data within something approaching a reasonable period of time, as well as the vitally important fact that the number of accidents to persons continue to show a diminishing record one third what has been the average for a number of years.

Structural Changes in Steel.

Standards Bureau Scientific Paper No. 356 contains the method of showing structural changes occurring in steel at high temperatures, and the extent of surface changes.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXIII | 114 Liberty Street, New York, May, 1920 | No. 5

Electrification of the Railroads in Switzerland

Last month we took occasion to note the vast improvements in electric traction that is so successfully climbing the Rockies and drawing the far ends of the North American continent nearer to-

VAL MELA VIADUCT, NEAR BRAIL ON THE LINE LEADING FROM BEVERS TO SCHULS-TARASP, SWISS NATIONAL RAILWAYS

gether, not speaking of making the scenic wonders of the Northwest more accessible to that rapidly increasing class who have the means as well as the desire to see the wonders of the West that surpass in magnitude, even though they do not excel in sublime grandeur, the more famed panorama of the Swiss Alps. The latter are also being opened up here and there, and the American tourists after seeing the battlefields of France, if they have any money left, should see Switzerland. Small as the country is the railroad men there are making the most of it. The fuel problem is not so pressing there as it is in some other countries. There are an unlimited number of waterfalls. The snow on the summits of the Alps is by no means eternal. It melts and rivers run from near the summits with a dynamic power that runs into fluxions. Of course they have nothing like Niagara Falls to draw upon, but what they lack in volume is made up in numbers. Every secluded village has a dozen waterfalls of its own, and the roar of the multitudinous torrents dashing over the dizzy crags is blended with the murmur of the turbines and the harmonious hum of the electric motors. The world moves and the Swiss engineers move with it. Thirty years ago narrow gage lines were opened here and there. The railway company which built these lines assumed the name of "Rätische Bahn," whatever that means, and undertook the task of developing the railroad system in the Swiss Canton of Grisons generally. The next undertaking was the building of the famous Albula railway leading from Thusis to St. Moritz. This line is 38½ miles long. The steepest grade is 35 per cent, and the lowest about 20 per cent. These, of course, were traversed by rack-rail steam engines. The highest point reached is in the Albula tunnel, 5,998 feet, the tunnel being about 3¾ miles in length, and which is the longest tunnel ever built for a narrow gage railway.

VIADUCT ON THE DAVOS-FILISUR LINE OF THE RHAETIAN RAILWAY—SWISS NATIONAL RAILWAYS

There are no less than 38 smaller tunnels, nearly all lined with masonry, and were finished in 1904. The work went on and the most remarkable engineering construction is the Wiesen Viaduct, partially shown on the frontispiece illustration, and more fully in the second illustration. It is 690 feet long, with 6 openings, each 66 feet wide, and a central parabolic arch of 180 feet span which strides across the Landwasser valley at the height of 289 feet. In 1912 a narrow gage electric line from Bevers on the Albula railway to Schuls-Tarasp, the celebrated Carlsbad of Switzerland, was completed; and while the electrification of the Swiss Federal Railway lines has made steady progress during the years of the great war, the Rhaetian Railway, too, has been active in this direction. The change from steam to electric traction has already been effected on the technically difficult Albula line, and rapid progress is being made in the electrification of other lines, some of which will be completed this year, and it is expected that the Rhaetian Railway will be electrified by the middle of 1923.

ELECTRIC LOCOMOTIVE OF 600 H. P. USED ON THE ELECTRIC LINE LEADING FROM BEVERS TO SCHULS-TARASP

Our third illustration shows the type of motors used on the Rhaetian Railway. It will be observed that they are of the 2-8-2 type, resembling very closely the earlier types of electric motors used on American railroads. They have a calculated traction force of 600 horsepower, and have been found well adapted for the light service, and with the unlimited water power to which we have already referred, it will, in all probability, take only a few years until the complete electrification of the Swiss railroads are accomplished.

Electric Locomotives of Brazil.

The International General Electric Company announced that it had been awarded a $2,000,000 contract for the first electrification of a steam railroad in South America—a 28-mile stretch of the Paulista Railway between Jundiahy and Campinas, Brazil. Including double track and siding, the total mileage to be electrified is 76. Electric operation is expected to begin in July, 1921.

Ultimately it is expected that 100 more miles of the main line will be electrified, extending the new system to Sao Carlos. Eight freight and four passenger locomotives for the first project will be built at Erie, Pa.

Test of Motor Locomotives on Danish Railways.

A motor locomotive equipped with a Diesel crude oil motor similar to that used in motor ships, has been ordered by the Danish State Railways for the purpose of conducting tests to determine whether such locomotives could be used to advantage on the Danish railroads. On account of the difficulties in obtaining coal and its high price (four or five times as high as before the war), the State Railways, says an issue of Politiken, will give the new type of locomotive thorough tests in order to determine whether or not it would be cheaper to use low-grade oils for fuel. If the motor locomotive is found satisfactory it is possible that the State Railways will install a large number. Similar tests are now being made on Swedish railroads, and it is reported that motor locomotives are now in successful operation in England.

A British Ten-Wheel-Coupled Locomotive

By W. Parker, President, Railway Club, London, England

For the first time in locomotive history a ten-wheel-coupled engine is in regular service on a British railroad. True, some twenty years ago Mr. James Holden built his celebrated "Decapod" for experimental work on the Great Eastern Railway, but that machine, which attracted much attention, was never used for a fixed and definite service.

Now, Sir Henry Fowler,—a Knight of the British Empire,—and chief mechanical engineer of the Midland Railway, has built at Derby Works a four-cylinder 0-10-0 locomotive for banking trains up the Lickey incline. This incline has a gradient of 1 in 37.7 and is famous throughout British railwaydom, nor has it escaped the attention of American observers, visiting the homeland of the Pilgrim Fathers. The new engine is numbered 2290 and takes the place of two heavy 0-6-0 banking engines that have hitherto been employed on this carefully conducted service.

The locomotive boiler is furnished with a superheater having 27 sets of elements. The boiler barrel is 5 ft. 3 in. diameter and 14 ft. long. The firebox—10 ft. long and possessing a grate area of 31½ sq. ft.—is tapered in two directions, the crown sloping downwards towards the back, and the two sides inwards in the same direction, the back plate being similar to those used on the compound express engines of the Midland Railway.

Though the boiler is designed for a working pressure of 200 lb. four 3⅛ in. safety valves are fitted, set to blow off at 180 lb. The boiler is fed by two hot-water injectors, and provision is afforded for warming the water in the tender by utilizing steam that otherwise would be blown off at the safety valves.

Cast in pairs, one steam chest to each pair, and bolted together, there are four cylinders, 16¾ in. diameter by 28 in. stroke. A notable feature of the cylinders is that cross ports have been introduced, making it possible for one piston valve to supply both cylinders on one side of the locomotive.

The front piston valve head serves the front port of the outside cylinder and the back port of the inside cylinder, and vice versa. At the back and front of the cylinders the covers are the same diameter, so that the cylinders for both sides of the engine, are cast off one pattern. The piston valves are 10 in. diameter, and are driven by Walschaerts' motion, the cut off in full gear being 75 per cent.

All the connecting-rods drive on to the middle axle. The incline is 1 in 7 to the horizontal, and the intermediate leading axle is cranked to clear the inside connecting-rod. Both for the cylinders and axle-boxes mechanical lubrication is provided. The locomotive is likewise fitted with steam reverse gear, the steam and water cylinders being fixed to the frames close to the reversing shaft and operated through pipes and valves on the foot-plate.

Engineers will understand that the severe gradient on the Lickey incline renders ample brake power imperative. Needless to say all the wheels are braked. The front three pairs are operated by a steam cylinder and shaft placed just behind the driving axle, and the two back pairs of wheels by a cylinder and shaft placed under the dragbox. Owing to the comparatively light tender, a hand brake has been fitted on the engine and it acts on all the wheels.

The principal dimensions are as follows: Working pressure, 180 lb. per sq. in.; heating surface, fire box, 158.25 sq. ft.; tubes, 1,560 sq. ft.; total, 1,718.25 sq. ft. Superheater (27) elements, 445 sq. ft.; grate area, 31.5 sq. ft.; cylinders (four), 16¾ in. diam. by 28 in. stroke; wheels, 4 ft. 7½ in. diam. on tread; tractive force at 85 per cent boiler pressure, 43,312 lb. = 19.336 tons.

Total weight of engine in working order, 73 tons, 13 cwts., 1 qr.; total weight of tender in working order, 31 tons, 11 cwts., 2 qrs.; total weight of engine and tender in working order, 105 tons, 4 cwts., 3 qrs.

The engine received special mention in the chairman's speech at the recent annual meeting of the proprietors of the Midland Railway and in Great Britain the public interest in this new type in British locomotive practice far exceeds the boundaries of ordinary mechanical engineering circles. Nominally it is the most powerful locomotive in the United Kingdom.

TEN-WHEEL-COUPLED BANKING LOCOMOTIVE ENGINE—MIDLAND RAILWAY OF ENGLAND

Scholarships at Stevens Institute

The Mechanical Section of the American Railroad Association has two scholarships at Stevens Institute of Technology, which will be vacant in June, 1920, and which are available for the sons of members of the Section and cover the regular tuition charges for a four-year course, leading to the degree of M. E. Applications for these scholarships should be in the hands of the Secretary not later than June 15, 1920. 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 upon application to the Secretary, V. R. Hawthorne, 1426 Manhattan Building, 431 South Dearborn street, Chicago, Ill.

Automatic Straight Air Brake Company's Triple Valve

Details of Its Construction and Operation

Our readers are aware that, for several years past, the Automatic Straight Air Brake Co. of New York has been engaged in the development of a new system of air brakes as embodied in a novel type of triple valve construction. As long ago as the fall of 1917 the valve had been so far developed that it was used in a 100-car rack demonstration test before a body of railroad officials, an account of which appeared in our issue of November, 1917, together with a description of the valve as it was then made.

This was followed by a similar test for the representatives of the Bureau of Safety of the Interstate Commerce Commission. After these tests the valves and the testing apparatus were removed from the rack and applied to a 100-car train on the Virginian Ry. Here an elaborate series of tests were made, both standing at Princeton and on a 1½ per cent. grade running from Princeton to Kelleysville, a distance of about 12 miles, concluding with a run from Princeton to Norfolk. An outline description of these tests was published in the *Railway and Locomotive Engineering* for August, 1918.

The results were so satisfactory that the use of the brake was recommended in the report made to Congress by the officials of the Bureau of Safety. While results obtained were all that could be desired, and several railroads were ready to place a trial order for the brake for application to both passenger and freight trains, the company felt that the triple valve had best be somewhat condensed and simplified before placing it definitely on the market. As it was built for these tests it consisted of three units, as shown in the illustrations of our issue for November, 1917. It was somewhat heavy and cumbersome. Accordingly, as soon as the tests on the Virginian Ry. were completed, the chief engineer of the company, Mr. Neal, set about the designing of a triple valve contained in a single unit, which should embody all of the operating features of the three-unit design and be contained in a single casing. This has now been done and the valve will soon be manufactured on a production basis.

As in the case of the three-unit valve, the principle of operation is very simple, and the controlling feature is to be found in three copper diaphragms whose movement is effected by the various air pressures to which they are subjected. These diaphragms are marked 15, 16 and 17 on the diagrammatic views of the valve that are here presented. The only part moved by the diaphragms is the pilot valve (19). The mechanism of the connection between the pilot valve and the diaphragms consists of a single lever fulcrumed at (74) and which multiplies the movement of the diaphragms at the pilot valve. All three of the diaphragms are rigidly fastened together at their center and so must move together.

The other moving parts of the triple, with one exception, are operated by the air. This exception is the release governing valve (43) which is manually operated, and by which the triple is made to work in quick or graduated release as will be explained later.

There are five moving parts that are operated by the various air pressures. The first of these is the operating pistons (22) and (23), with their connections. Closely connected with them is the emergency slide valve (5). Then, at the top there is the main slide valve (12) and graduating valve (13). Finally there is the automatic emergency valve piston (7) with its connections.

As it would be quite impossible to draw any section or sections through the valve, as made, that would show the several air passages used, resort is made to diagrammatic views which clearly show the whole scheme of construction. Then, in order that the flow of air can be readily followed, the several air pressures as they exist in the brake pipe, emergency reservoir, brake cylinder, brake-pipe reservoir and the atmosphere are shown by corresponding sectioning.

Outside the triple valve there is the usual auxiliary reservoir, now called the emergency reservoir, and operating brake cylinder and a brake-pipe with a brake-pipe reservoir, from which air is drawn for the usual service applications of the brake.

As indicated on the engravings of the diagrams there are five pipe connections to the valve. These are for pipes leading to the retainer, the brake-pipe reservoir, the emergency reservoir the brake-pipe and the brake cylinder. Two other openings (A) and (B) lead to the atmosphere.

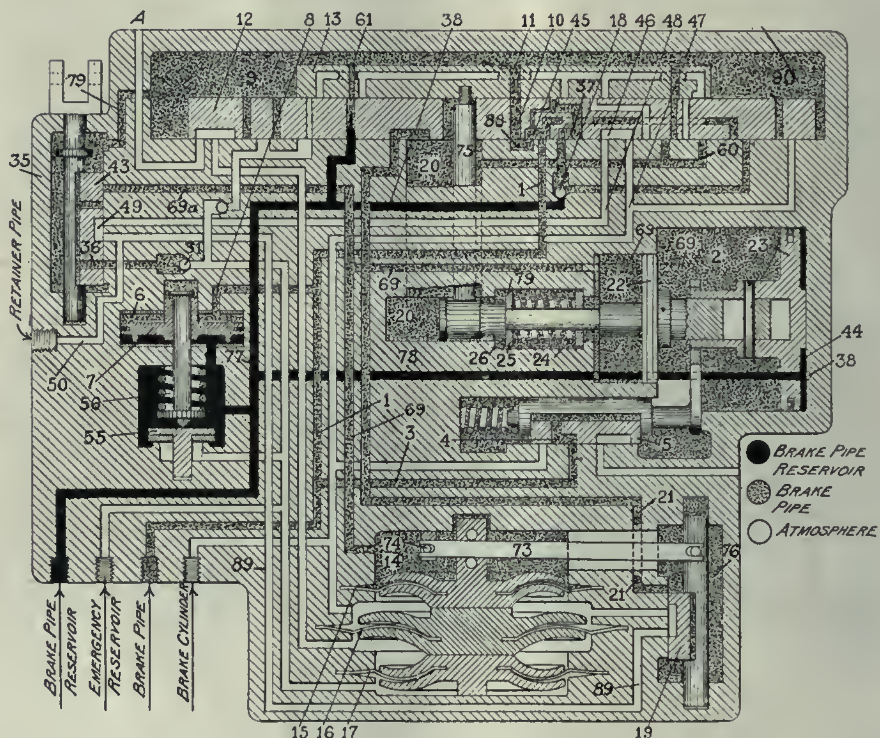


FIG. 1 FULL RELEASE POSITION—BRAKE PIPE RESERVOIR CHARGING TRIPLE VALVE IN QUICK RELEASE

Before taking up the operation of the valve attention is called to the three diaphragms, where it will be seen that the upper (15) and lower (17) are of the same diameter, while the central one (16) is larger.

FULL RELEASE AND CHARGING

First taking up (Fig. 1), which shows the flow of the air during the period of charging after a release of the brakes or with the system empty and charging.

With the system empty the parts may be in any miscellaneous set of positions, with the exception of the automatic emergency valve piston which with its connected valve (55) is held against its seat by the spring 56.

Air from the brake-pipe enters at the

point indicated and flows up through the passage (1) into the passage (3) and thence up through the port (4), in the emergency valve, to the back of the same and thence around the operating stem of the same into the chamber (2) between the pistons 22 and 23. As the piston (23) is the larger of the two, the difference in pressure causes the whole to move to the right until the piston (23) strikes the end of its cylinder. In this it carries the stem (75) with it and moves the main slide valve (12) and the graduating valve (13) into the position shown.

From the chamber (2) the air flows through the passage (69) up and into the passage (69a) to the face of the release governing valve (43) where it is stopped. But the air continues down through the passage (69) to the chamber (14) above the top of the upper diaphragm (15). As the space between the diaphragms, as well as that below the lower diaphragm (17), is filled with air at atmospheric pressure, the whole diaphragm system is forced down to its lowest position.

In taking this position the diaphragms have moved the pilot valve (19) to its lowest point and it has opened the end of the passage (21).

At the same time the brake-pipe pressure has passed through the chamber (14) along side of the lever (73) and into the chamber (76) around the pilot valve. Thence it flows up through the passage (21) to the port in the face of the main slide valve and into the chamber (20) and so down filling the spaces to the left of the piston (22) and at the top, it also fills the passage (60). The brake-pipe air also flows on up through the passage (1) turning aside through the passage (8) to fill the space (6) above the emergency valve piston (7) and on up to the port (45) in the main slide valve, thence through the ports (10) and (11) to the chamber (9) above the graduating valve.

As the air rises into the port (45) in the face of the main slide valve it flows around into the port (37) and thence down to the top of the check valve (18) which stops its further flow.

From the chamber (9) above the valves (12) and (13) the brake-pipe air flows down through the ports (61) through the two slide valves to the passage (38) and (77). In the former it flows to the bottom of the check valve (18) and from the latter to the passage (78) to the space at the right of the piston (23). It also continues down and out to the pipe connection to the brake-pipe reservoir. The pressure in the latter being indicated by the appropriate shading from the port (61) in the main slide valve.

The system is thus in equilibrium so far as the triple is concerned.

In Fig. 1, the release governing valve (43) is shown in the quick release position. When so situated the brake-pipe air from the chamber (9), flows through the passage (79) to the chamber (35) of the release governing valve. From this it flows through the port (36) in the valve to the back of the check valve (31) which stops the flow into the emergency reservoir.

The parts of the valve remain in this position until the brake-pipe reservoir pressure has been built up to that of the brake-pipe.

When this has been accomplished the pressure upon the two sides of the large piston (23) are equalized.

It will be noticed that in Fig. 1, when the pistons have been moved to the right the follower (79) of the spring (24) has been drawn away from the shoulder and the spring (24) compressed.

When the pressures upon the two sides of the large piston (23) have equalized, and the brake-pipe and brake-pipe reservoir pressures are the same, the spring (24) can expand and push its follower back against the shoulder (26) and thus move the pistons into the position shown to be occupied in Fig. 2.

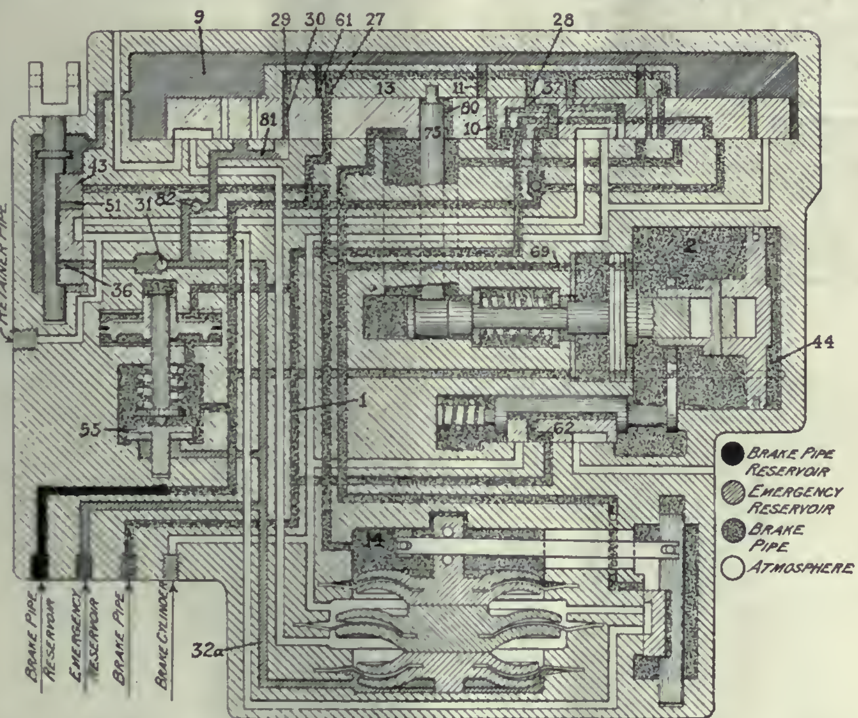


FIG. 2. FULL RELEASE POSITION—CHARGING EMERGENCY RESERVOIR TRIPLE VALVE IN QUICK RELEASE

CHARGING EMERGENCY RESERVOIR

In Fig. 2, as the brake-pipe and brake-pipe reservoir pressures are the same the marking of the former is shown as occupying all of the spaces and passages shown as filled with brake-pipe reservoir pressure in Fig. 1.

It will be seen that, in moving to their new position the pistons have moved the stem (75) from being nearly in contact with the right hand side of the slot (80) in the main slide valve to nearly in contact with the left hand side of the same; that it has carried the graduating valve (13) with it but left the main slide valve (12) in its original position. In thus moving the graduating valve, it has moved its port (11) out of register with the port (10) of the main slide valve and covering the latter, so that brake-pipe pressure is now cut off from the chamber (9). But it has brought the port (28) of the graduating valve into registration with the port (37) of the main valve, as well as port (29) in register with port (30). Air at brake-pipe pressure now flows through ports (29) and (30) into the passage (81) and to the underside of the check valve (82), which it opens against the atmospheric pressure heretofore existing behind it, and flows down through the passage (32a), filling the space beneath the automatic emergency poppet valve (55) and also out and into the emergency reservoir, and the space beneath the diaphragms.

This position of the valve holds until all parts shown as filled with brake-pipe, brake-pipe reservoir and emergency reservoir pressures are equalized and then the system is fully charged. The release governng valve being still in the quick release position. Attention is here called to the prevalence of emergency reservoir pressure in the chamber (9) instead of the brake-pipe pressure previously prevailing. While the two are the same, it will be seen that the possible movement of air from the emergency reservoir past the check valve (31) holds the pressure in the chamber (9) up to that pressure instead of permitting it to fall with the brake-pipe pressure.

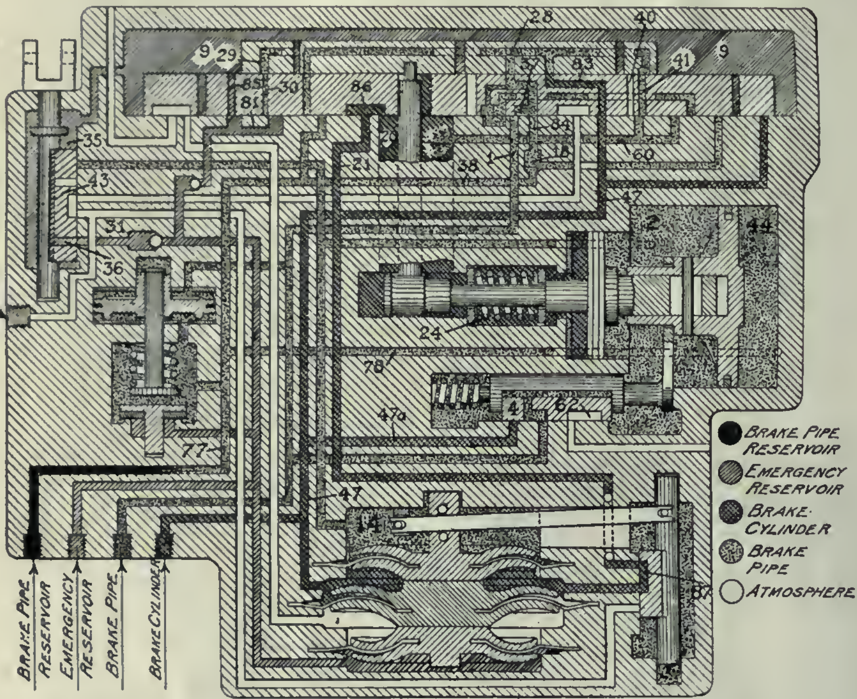


FIG. 3. SERVICE POSITION—TRIPLE VALVE IN QUICK RELEASE

SERVICE APPLICATION

After the system is fully charged, it is ready for an application of the brakes and this, under the conditions of a service application, is shown in Fig. 3. It is accomplished, in the usual way, by making a reduction of brake-pipe pressure.

Suppose, then, that the brake-pipe pressure is reduced in the regular way. Referring to Fig. 2, this reduction is first felt through the passage (1) and port (4) of the emergency valve, and then in the chamber (2) between the pistons. From there the reduction is carried to the chamber (14) above the diaphragms by way of the passage (69). This lowering of the pressure in the chamber (14) permits the emergency reservoir pressure beneath the lower diaphragm to raise the whole diaphragm system and with it the pilot valve so that its port (87) connects the passage (21) with the space between the upper and central diaphragms. This opens a direct communication between the chamber (20) and the brake cylinder by way of the port (87) and the passage (21).

Such a communication causes a discharge of pressure from the chamber (20) into the brake cylinder which so lowers the pressure in that chamber that the brake-pipe pressure in chamber (2) pushes the pistons to the left compressing the spring (24) and bringing the parts to the position shown in Fig. 3.

The pistons are stopped in this service application position, because, as they move, communication is opened from passage (1) through passage (28) and ports (40) and (41) to the chamber (20), thus emptying the brake-pipe pressure into the brake cylinder and building up a pressure therein which prevents an excessive movement of the pistons to the left.

When the main slide valve is moved to the new position, there is an immediate equalization of the pressures in the chambers (2) and (44) on either side of the large piston by way of the passages (78), (77), (38), the port (37) in the main slide valve and the passage (1) to the chamber (2) by the route already described. As this occurs the large piston has become inoperative because of the equalization of the pressure on its two sides.

At the same time the air from the brake-pipe reservoir is flowing up through the passages (77) and (38) to the under side of the check valve (18) which it lifts and then, flowing through the ports (37) and (28) around to (83), it enters the passage (47) and thence directly to the brake cylinder.

This flow would continue until the brake-pipe, brake-pipe reservoir and brake cylinder pressures were equalized, were it not for the action of the diaphragms.

SERVICE LAP POSITION

Attention has already been called to the difference in diameter between the central and lower diaphragms. This difference is such that the downward pressure on top of the central diaphragm to overcome the upward pressure of the emergency reservoir beneath the lower diaphragm, must be 2½ times the difference between the brake-pipe pressure in the chamber (14) and the emergency reservoir pressure.

For example, if a brake-pipe reduction of 10 lbs. be made, the emergency reservoir pressure remaining unchanged, then the air from the brake-pipe and brake-pipe reservoir will flow

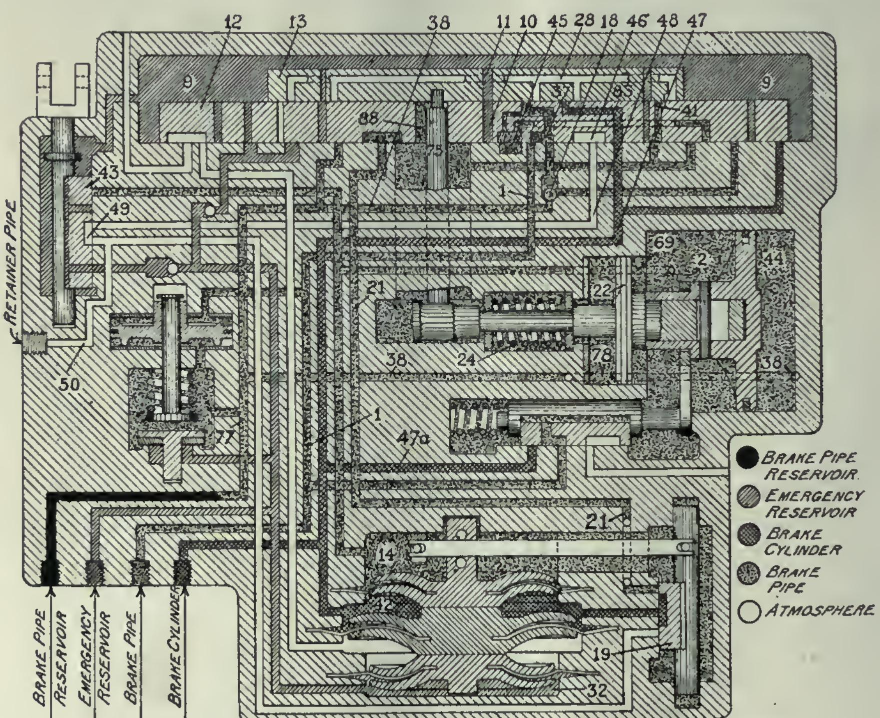


FIG. 4. SERVICE LAP POSITION—TRIPLE VALVE IN QUICK RELEASE

into the brake cylinder, until its pressure has risen to 25 lbs. per sq. in. When this pressure has been attained the diaphragms are pushed down, carrying the pilot valve (19) with them, to the service lap position, shown in Fig. 4.

When this occurs the spring (24) pushes its right hand follower against its stop and moves the pistons to the right as in Fig. 4. It will be seen, however, that the pistons are not as far to the right as in Fig. 2, where the spring was fully expanded because of the play of the followers and spring on the piston stem. Nor is the main slide valve carried back, as the stem (75) merely moves across the slot (88) in the main slide valve. This brings the graduating valve (13) into the same relative position with the main slide valve (12) that it occupies in Fig. 1. This cuts the port (28) out of register with the passage (83), stopping the flow of air to the brake cylinder, a flow that is also stopped into the space (20) by the movement of the port (28) out of register with the passage (41).

With the pilot valve in the position shown in Fig. 4, the connection between the passage (21) and the brake cylinder is broken and the ends of the passage (47) are blocked by the main slide and graduating valves.

All of the passages from the brake cylinder are thus completely blocked and the pressure is locked in, as in the emergency reservoir. But, if there is a leakage from the brake cylinder with a consequent fall of pressure, the emergency reservoir pressure beneath the lowest diaphragm at once lifts the three and these raise the pilot valve (19) so that a connection is made between passage (21) and the passage to the space between the upper and central diaphragms and the brake cylinder, whose pressure is at once raised to the proper point for again causing the diaphragms to drop.

Thus a uniform pressure is maintained and it will be seen why it is that this valve produces a uniform brake cylinder pressure throughout a train, for any given brake-pipe reduction regardless of the travel of the brake cylinder piston.

OPERATION OF GRADUATED RELEASE

Suppose now that when the system is charged, as in Fig. 2, the release governing valve (43) is raised to the graduated release position. This is shown to have been done in Fig. 5. The port (51) through release governing valve is brought to register with the passage (69a) while passage to the back of the check valve (31) is blocked. This does not disturb the charging of the system in any way except that it cuts off the flow of air from the emergency reservoir to the chamber (9) above the slide valves; and, after the emergency reservoir has been charged to brake-pipe pressure, the pressure is locked in by the check valve (82), which, however, will open to permit a flow of air into the emergency reservoir, to make up for any leakage there.

This shutting up of the emergency reservoir pressure so that it cannot escape establishes the working feature of the graduated release.

Referring back to Figs. 1 and 2, it will be seen that, when the brake-pipe pressure is raised, the pressure in the space (2) between the pistons is raised they are moved to the release position of Fig. 1. The emergency reservoir pressure below the bottom diaphragm then flows up through the passage (32a), through the check valve (31) into the space (35) and so on to the space (9) above the slide valves. As these valves move back to the release position, ports (10) and (11) are brought into alinement and register with the port (88) in the valve seat, and, through it, open communication with the passage (1), the pressures below and above the diaphragms are equalized, and the brake cylinder pressure on the central diaphragm moves the whole system down, carrying the pilot valve (19) with it and placing the space between the upper and central diaphragms in communication with the passage (89) which leads to the retainer pipe connection or to the atmosphere. A connection is also made from the brake cylinder to the same point through the passage (47), the port (46) in the face of the main slide valve, and the passage (48).

This means, of course, a sudden drop in the brake cylinder pressure to zero.

But, when the release governing valve is in the graduated release position, shown in Fig. 5, the emergency reservoir pressure is locked in beneath the diaphragms by the check valve (82) and so when the brake-pipe pressure is raised it may move the parts to release position, but there is no sudden equalization of pressure between the chambers above and below the diaphragms. That at the bottom is held constant and that above, in chamber (14), rises slowly with the brake-pipe pressure. As it does, the differential pressure between it and the brake cylinder is slowly decreased and the diaphragm system slowly rises under the influence of the emergency reservoir pressure at the bottom. This slow movement is reflected in that of the pilot valve, whose port opening is correspondingly slight, allowing only a portion of the brake cylinder pressure to escape.

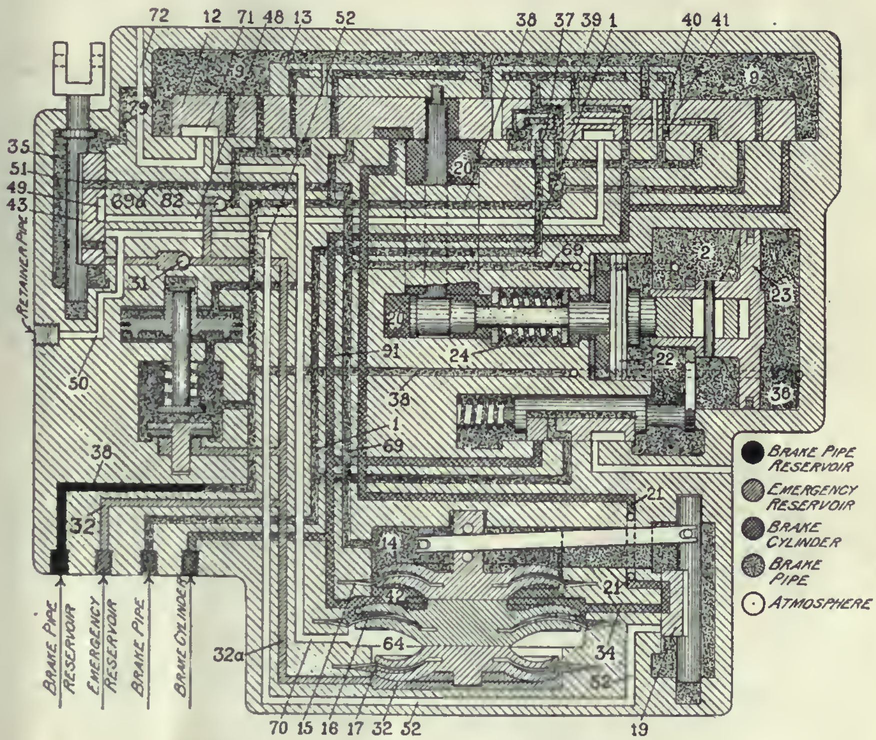


FIG. 5. SERVICE POSITION—TRIPLE VALVE IN GRADUATED RELEASE

Thus the brake cylinder pressure is held under control and may be made to rise or fall just in proportion to the corresponding decrease or rise in the brake-pipe pressure.

Thus the brake cylinder pressure is automatically held at 2½ times the brake-pipe reduction regardless of brake cylinder piston travel.

When operating the brakes in graduated release the port opening in the pilot valve is so restricted that it is impossible, when braking long trains, to release the head brakes faster than the rear brakes, when operating the engineer's valve in full release position.

EMERGENCY POSITION, TRIPLE VALVE IN QUICK RELEASE

We now come to the last of the series of movements, the emergency application. The position of the parts in this condition are shown in Fig. 6.

The sudden lowering of the brake-pipe pressure has a corresponding effect on that in the space (2) between the pistons. This drop causes the pressure in the space (44) at the right of the piston to move the latter violently to the left, compressing the spring (24) and, striking against the arm of the emergency valve, and moving that valve to the left and into the position shown. In this position the port (62), in the face of the valve, puts the passage (3), which leads off from the passage (1) of the brake-pipe, in communication with the one to the opening (B) to the atmosphere, thus making a local vent in the brake-pipe.

At the same time that the above occurs, the emergency reservoir pressure beneath the emergency valve (55) lifts that valve, as it can because of the, then, absence of pressure above the piston, and thus puts the emergency reservoir in communication with the passage (77) leading to the brake-pipe reservoir and the passage (78) leading to the space (44) at the right of the piston. This pressure, at that point, serves to hold the pistons in the emergency position until the action is completed. It will be noted that the brake-pipe pressure is now cut off from any connection with the space (2) between the pistons.

The movement of the pistons, to the left, has carried the two slide valves also to the left. This places the graduating valve (13) in the same position relatively to the main slide valve (12) that it occupied in Figs. 2, 3 and 5, but the main slide valve has been moved so far that the passage and port (57), leading to the passage (47) and the brake cylinder, is opened; the port (58) is made to register with the passage (92) which leads to the passages (38) and (77) and the connection to the brake-pipe reservoir, while at the left the port (93) in the main valve registers with the upper end of the passage (70), leading from the space between the central and lower diaphragms and which is ordinarily filled with air at atmospheric pressure.

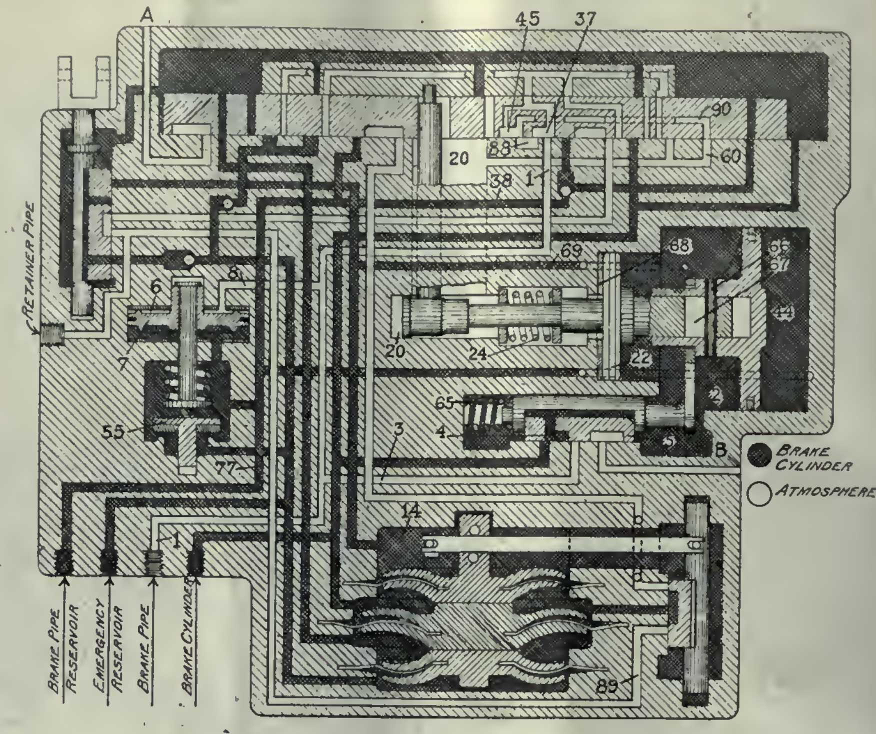


FIG. 7. EMERGENCY LAP POSITION— TRIPLE VALVE IN QUICK RELEASE

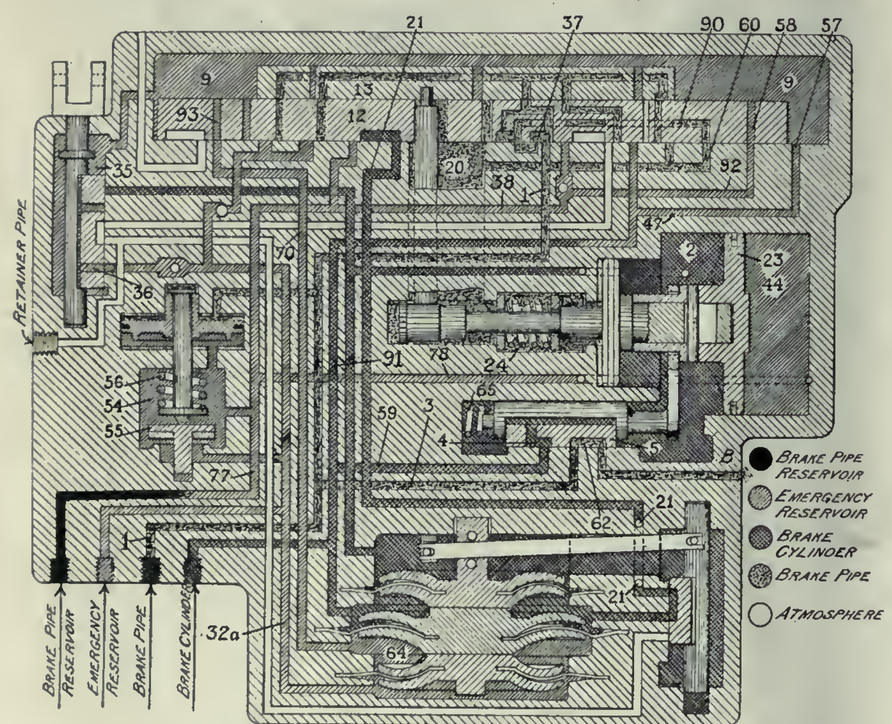


FIG. 6. EMERGENCY POSITION—TRIPLE VALVE IN QUICK RELEASE

In this position the brake-pipe is shut off from all connection to other parts of the valve and is opened directly to the atmosphere at (B) through the passages (1) and (3) and the port (62) of the emergency valve.

Then the brake-pipe reservoir is opened to the space (54) below the piston of the automatic emergency valve which it holds up. It is also opened into the space (9) above the slide valve by the way of the passages (77), (38), (92) and the port (58), as well as into the space (44) at the left of the large piston, through the passage (78).

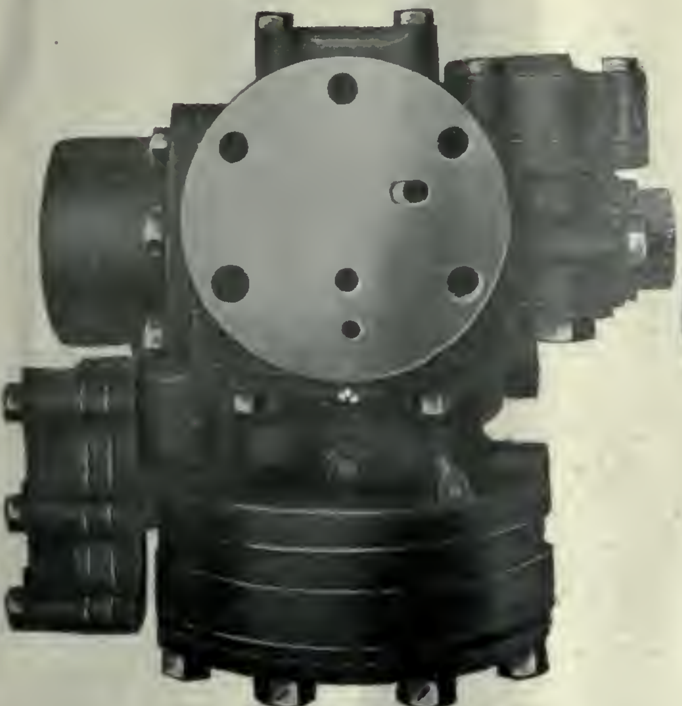
The emergency reservoir is opened to the space below the automatic emergency valve by the way of the passage (32a), and, this valve being opened, the connection is made to the space above the slide valves, by the same route as that of the brake-pipe reservoir.

From the space (9) above the slide valves this combined emergency and brake-pipe reservoir pressure flows down through the passage (57) into the passage (47) to the brake cylinder, turning aside into the passage (59) to pass through the port (4) in the automatic emergency valve (5) to fill the space (2) between the pistons.

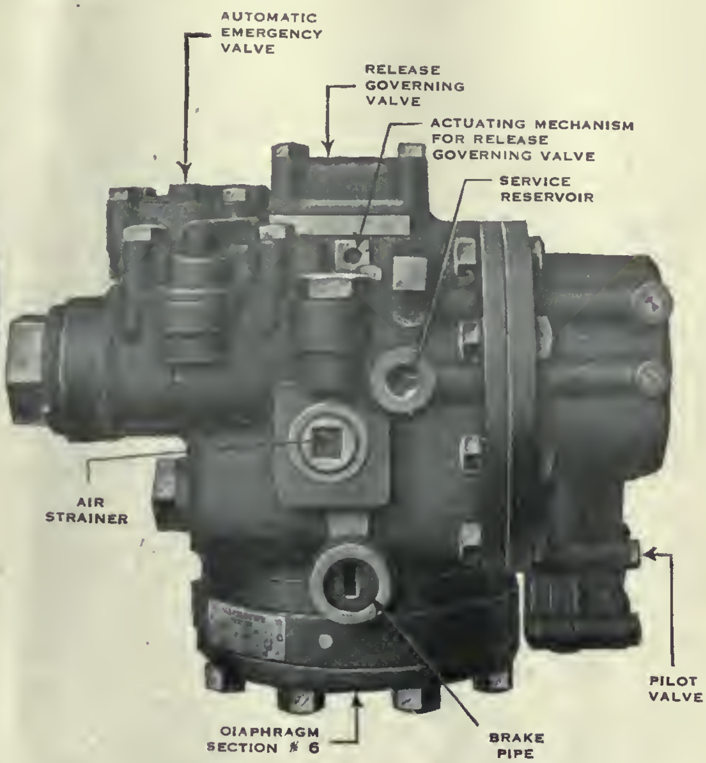
This condition holds until the brake-pipe reservoir, emergency reservoir and brake cylinder pressures have equalized.

Emergency Lap Position, Triple Valve in Quick Release.

When this has occurred the diaphragms move down to a central position, and the spring (65) on the stem



Auxiliary Reservoir Side. Type S-2 Triple Valve



Type S-2 Front View. Triple Valve

of the emergency valve pushes that valve to the right until the connection between the brake-pipe passage (3) and the atmosphere at (B) is broken. This occurs when the pin (66) in the hub of the large piston has traversed the length of the slot (67) in the piston stem.

The piston can go no further because the pressure on its two sides are equalized and the small piston is held to the extreme left of its travel by the brake cylinder pressure on the right, while brake-pipe or atmospheric pressure is on the left. This is the condition and position of the parts shown in Fig. 7.

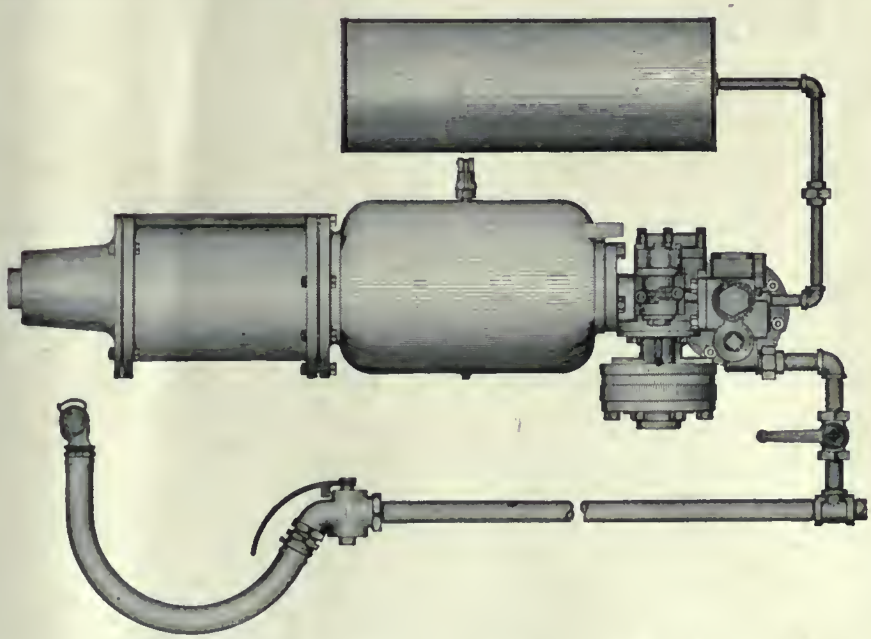
With all passages and spaces equalized in this way and the brake-pipe closed to the atmosphere, the triple is ready for an increase of brake-pipe pressure and the release of the brakes.

The first thing to happen when the brake-pipe pressure is increased is that the air flows through the passages (1) and (8) into the space (6) above the emergency valve piston (7). A comparatively low pressure will push the piston down and close the valve (55). It also flows on up through the passage (1) to the port (37) in the main slide valve, thence by the port (88) in the seat and the port (45) in the valve to the passage (90), thence through the passage (60) to the space (20) at the left of the small piston. As soon as the pressure in this space has risen to that of the brake cylinder in the space (2), it will move the pistons to the right, allowing the spring of the stem of the emergency valve to move it to the position of Fig. 1. As soon as the pressure starts to build up in the space (2) between the pistons it does the same, by way of the passage (69), in the space (14) above the diaphragms. And when the pressure at this point has risen so as to force the diaphragms and with them the pilot valve down, that event occurs and the brake-cylinder is opened to the atmosphere by the way of the port in the pilot valve and the passage (89).

The valve is then back into the charging position assumed at the opening of this article.

Automatic Emergency Application

There is another feature of this triple valve which is unique. It will have been noticed that the air from the emergency reservoir has not been drawn upon in any of the braking operations except the emergency application, so that under the ordinary conditions of operation it remains at



A. S. A. Triple Valve with Brake Cylinder and Emergency Reservoir or nearly to its normal maximum.

The chamber (54) of the automatic emergency valve is in direct communication with the brake-pipe reservoir. When the pressure of this reservoir has been reduced to 25 lbs. the pressure of the emergency reservoir existing below the poppet valve (55) lifts that valve against the tension of the spring (56) above it and thus makes a connection between the emergency reservoir and the chamber (44) at the right of the large piston by way of the passage (78). The sudden and high increase of pressure in this chamber forces the piston to the left, moves the emergency valve to the emergency position, establishes communication between the brake-pipe and the atmosphere, and causing an automatic emergency application of the brakes to be made.

The general appearance of the assembled triple valve is shown in Figs. 8 and 9. And the size relatively to the auxiliary reservoir can be judged from the engraving, Fig. 10.

Need of Improved Facilities in Railroad Shops.

Frank McManamy, formerly Assistant Director, Division of Operation, United States Railroad Administration, says that "the railroads have not, as a general rule, organized their mechanical departments on a manufacturing basis, but have depended upon outside sources for the great proportion of their manufactured products, and such shop facilities as they have maintained have been largely for repair and maintenance work. Because of the diversified products of the ordinary railroad repair shop, the question of production has not been given the consideration it has in other fields. Such work has usually been carried on as a side line at the largest repair shops on the individual roads. On this basis, it has been found economical to install special machinery and methods at a centralized point and manufacture pieces in quantities for storehouse stock, to be distributed on requisition to the smaller shops or terminals over the system.

During the past few years great improvement has been made and is still being made in the design of machine tools and special machinery for railroad shop work. The installation of automatic and semi-automatic machinery adapted for railroad shop uses has been extended. The introduction of modern high-capacity and special machinery has not always been an economical procedure, however, because the output of the shops where installed has not been particularly adapted to the machinery or because in the average shop such machinery can be used only part time.

With increasing cost for material and labor it will be necessary to reorganize shop facilities with a view to keeping equipment maintenance costs within reason; therefore, modern methods of shop production should be applied to railroad work as rapidly as possible.

It is usually estimated that the locomotives on a railroad represent approximately eight percent of the total cost of the property, but it is this eight percent which makes the other ninety-two percent profitable, so that, even assuming that by suitable shop facilities and efficient shop operation we are able to reduce our percentage of unserviceable locomotives from twelve percent to ten percent, we have done more than the percentage figures indicate, since the amount of transportation which can be furnished is represented by the number of serviceable locomotives."

The Railroad Labor Board

The Railroad Labor Board, whose duty it is to hear appeals of the railroads or their employees from the decision of lower adjustment boards when the latter fail to reach a unanimous agreement on matters under dispute has been appointed by the President, and the decisions of this Board are to be final. It relies for its effect upon the force of public opinion, and makes it the duty of railroads and their employees to exert every reasonable effort and adopt every available means to avoid any interruption of interstate commerce. There is no specific stipulation for the creation of the minor boards, their establishment by the railroads and their employees remaining voluntary.

The Interstate Commerce Commission states that members of the Labor Board have been chosen from the regularly organized bodies because 90 per cent of the railroad employees were included in their membership. The Railway Executives are selected on the same principle because approximately 95 per cent of the railroad mileage is included in the association. There are also delegates chosen to represent the public, three delegates from each of these classes forming a board of nine members, and conjointly armed with full power to take jurisdiction over disputes which threaten interference with interstate commerce. To this end the board has authority to subpoena witnesses and documentary evidence, failure to obey a subpoena of the court being treated as an act of contempt.

The final motion in Congress creating the Railroad Labor Board was carried by a vote of 250 for the enactment, with 150 against the measure, and like all other legislative enactments is subject to future amendments. That it will get a fair trial is a hoped-for conclusion, the labor element through their executives declaring openly that in the interests of railroad labor "there is nothing left for us to do at present except to co-operate with each other in the prompt creation of the machinery as is provided for in this law."

The members of the Board, nominated by the President and confirmed by the Senate, are: Representing the Railroads—Horace Baker, J. H. Elliott and William L. Park. Representing the Railroad Employees—Albert Phillips, A. O. Wharton and James J. Forrester. Representing the Public—George W. Hangar, Washington, D. C.; Henry Hunt, Cincinnati, Ohio, and R. W. Barton, Tennessee.

The large majority of the Board are men of wide experience in railroad matters. Of those representing the railroads, Horace Baker, who is appointed for a three-year term, was formerly general manager of the Cincinnati, New Orleans & Texas Pacific Railroad, and has served 40 years in various capacities and various positions on railroads, mostly in the central and southern districts. J. H. Elliott of Texas, who is appointed for two years, was formerly general manager of the Texas & Pacific Railroad, and during the war was colonel in the transportation corps of the American Expeditionary forces. William L. Park, who is appointed for one year, has been in railroad service, chiefly in the west, since 1875, when he began as brakeman on the Union Pacific and finished as general manager in 1910, when he was appointed general manager of the Illinois Central, and latterly elected vice-president of the Chicago Great Western Railroad.

Of those representing the railroad employees, Albert Phillips is vice-president of the Brotherhood of Locomotive Firemen and Enginemen, and is appointed for the three year term. A. O. Wharton, who is appointed for two years, has served as an official of the railway employees' department of the American Federation of Labor, and also as a member of the railway wages and working conditions of the United States Railroad administration, which has been discontinued. James J. Forrester, who has been appointed for one year, was elected last year President of the Railway Steamship Clerks, Freight Handlers, and the Express and Station Employees.

Of those representing the public Judge R. M. Barton has made an excellent record as judge of the Tennessee Court of Appeals, and is appointed for three years. George W. Hangar, appointed for two years has been serving as assistant commissioner of the United States Board of Mediation and Conciliation, and has a wide experience in the settlement of labor disputes. Henry Hunt, appointed for one year, has served for seven years as a member of the board of trustees of the Cincinnati Southern Railway, the only railroad in America owned by a municipality. He served as captain in the United States army during the war, and was formerly Mayor of Cincinnati, and at one time member of the Ohio House of Representatives.

General Observations on Valve Motion

Valuable Hints on the Economical Distribution of Steam

The high standard of papers read at the meeting of the Canadian Railway Club is being admirably maintained, and at a recent meeting held in the Windsor Hotel, Montreal, F. Williams, Mechanical Designer, Canadian Natural Railways, Moncton, N. B., presented "Observations on Locomotive Valve Motion" that are well worthy of perusal by all who are in any way interested in the construction and adjustment of locomotive valve gears. While much that is altogether excellent has been already published in a number of text books, supplemented by the contributions of the engineering press, it will be admitted that the trained engineer or intelligent mechanic learns much that has little chance of appearing in print. It is therefore of real value to find an engineer so well equipped as Mr. Williams, not only in the high quality of keen observation, but in the still higher quality of imparting the results of his experiences to others. It is a mistake to imagine that a problem so involved as the harnessing of steam or any other of the elemental forces of nature can ever be fully mastered. Perfection eludes and ever will elude the seeker after the ideal, and real progress however slow, should not only be looked for but should be encouraged. Mr. Williams' paper is not only a notable contribution to the literature already existing on the subject which he has treated so ably, but is in itself an encouragement to others to continue their investigations in the same field. The lack of space precludes us from presenting or from reproducing the discussion that followed the presentation of the paper, which we might supplement by experiences coming under our observation. It is as well, at present, to reproduce the most of the essay as prepared by Mr. Williams, and allow our readers to draw their own conclusions:

"The duties which a locomotive valve gear has to perform are exacting in the extreme, as it has to control the distribution of steam to the cylinders with almost perfect precision through a wide range of cut-offs in forward and reverse direction. There is no apparatus on a locomotive upon which the economical working depends so largely, and when we consider that at diameter-speed the movement of the distribution valve is reversed 672 times per minute, we can appreciate with what care the design must be undertaken.

"From the point of view of economical steam distribution, valve motion design has to-day reached a point where it cannot be greatly improved upon, and the chief attention of the designer has for the last few years been taken up with questions of accessibility and low maintenance cost, his aim being to apply a gear which would run and keep square from shopping to shopping with the minimum of attention.

"Considered from the standpoint of steam distribution alone, I doubt if a well designed and properly set Stephenson gear has ever been excelled, but owing to inaccessibility, high maintenance cost and its great liability to get out of square due to the springing of parts and development of lost motion, the Stephenson gear has become a back number, and I shall only refer to it for purposes of comparison.

"For several years past practically every locomotive built in this country has been equipped with an outside gear, the vast majority with Walschaerts', and to this gear I shall devote most attention.

"The simplicity of the gear lies in the fact that the valve receives its motion from two sources, first from the crosshead through the combination lever, and second from the eccentric through the link, and each of these sources of motion can be dealt with separately without considering the influence of the other in designing and setting. The motion derived from the combination lever is equal to the steam lap plus the lead and it attains its maximum travel when the engine is on the dead center. It is not affected in any way by the reverse gear, but remains the same in all positions of the lever.

"The motion derived from the link is simply a symmetrical motion front and back of the center line, and is increased or decreased according to the distance of the link block from the center of the link.

"When the link block is exactly in the center of the link there is, of course, no motion from this source and as the block gets by the center the motion is reversed. When the engine is on the front or back dead center the link assumes such a position that the reverse lever can be moved backward and forward through the entire travel without imparting any motion to the valve, and the distance that the valve is off the center is entirely due to the position of the combination lever which is at its maximum travel at these points.

"The length of the combination lever from the radius bar connection to the union link connection must bear the same proportion of its length from the radius bar connection to the valve steam crosshead connection as does half the stroke of the piston to the lap plus the lead plus 1/64 in. The 1/64 in. is added to the lap plus the lead to take care of the lost motion. Care must be taken that the length of the combination lever adopted will bring the lower end of the lever to the correct level to connect up with the union link, especially if the union link is connected directly to the wrist pin, which is the practice generally adopted.

"The radius of the link slot center line is, of course, determined by the length of the radius bar, and the preferred location of the link support bearings is such that the horizontal center line is on a level with the radius bar connection to the combination lever. This location may be varied within reasonable limits without affecting the valve events to any appreciable extent; for instance, on a locomotive with a very large cylinder the steam chest center line and the cylinder center line are of necessity quite a distance apart and in this case the link support is sometimes lowered an inch or two to bring the link tail nearer to the horizontal center line of the axle.

"The angle through which the link rocks should not exceed 45 deg., and if it can be kept lower so much the better. The eccentric rod connection to the link tail should be kept within 3 or 4 ins. of the horizontal center line of the axle in order to keep the angularity of the eccentric rod within limits and owing to this angularity of the rod, it will be found necessary to offset the tail connection of the link in order to give it the same angular travel on either side of the central position. I have heard men with a good deal of experience state that an approximately correct offset is all that is required, but as it is just as easy to make this offset correct as otherwise I always prefer to make it dead right.

"The eccentric crank must be set so that it brings the link dead on its central position when the engine is on either front or back dead center and the throw of the eccentric pin must be such that, acting in combination with the radius of the link tail, it will give the required angular travel to the link.

"The reverse shaft location, length of arm, and swing link are very important considerations, and unless great care is exercised in the arrangement of these details the efficiency of the motion may be considerably reduced. The arc which the reverse shaft arm describes should be so arranged as to reduce the link block slip to a minimum in all positions of the reverse lever, special attention being paid to the running position in fore gear.

"It is impossible to avoid link block slip altogether, but it can be kept pretty low, and if this is not carefully looked after the effect will be seen in the valve events and also in the wear on the link and link blocks. The steam chest center line should be outside the cylinder center line far enough to permit of bringing the whole motion into practically a straight line, thus eliminating the necessity for rockers and doing away with the twisting effect and lost motion which the use of rockers involves.

"Engines equipped with the Walschaerts' valve gear should be so arranged that the link block is in the bottom half of the link for forward gear, the eccentric, of course, following the crank pin. The advantages of this arrangement are that the wear in the link support bearings is diminished and the link block slip in running position may be kept very small, as the swing link describes an arc which is very similar to the arc struck by a point in the bottom of the link, the concave side of both these arcs being uppermost.

"It is very important that the design of this gear should be as good as it is possible to make it, for if it is faulty, it is impossible for the valve-setter to correct its faults. If the design is good all the valve events naturally come within very close limits of being square, but if they do not there is practically nothing that the valve-setter can do to correct them. A perfect steam distribution will, of course, give a perfect exhaust, but a perfect sounding exhaust does not necessarily mean a perfect steam distribution. The steaming properties of the boiler and the fuel economy depend very greatly on the evenness of the exhaust, and if the exhaust is ragged the vacuum in the smokebox is unsteady and the fire is soon pulled in holes, resulting in a great waste of fuel. The designer therefore endeavors to obtain a perfect exhaust by giving as nearly as possible a perfect steam distribution, the valve-setter has to get an even exhaust at all costs.

"The usual setting of a Walschaerts' gear is square on dead centers, with a constant lead in all positions of the reverse lever, but the main object of lead is to give an unrestricted supply of steam to the cylinder when the piston begins its stroke, and with the preadmission down to about 1/64 in. it is impossible that the steam admitted to the cylinder can exert any appreciable turning movement on the axle until the crank pin has gone over the center.

"Fig. 1 shows a valve diagram plotted for one of our large passenger engines. This engine has 24 in. by 28 in. cylinders, a 14 in. valve, 6 in. steam travel, ¼ in. constant lead, 1 1/16 in. steam lap and ¼ in. clearance. The broader ellipse in the center shows the valve travel in relation to the piston travel on full forward gear, and the narrow ellipse inside it shows the same thing with the lever notched up to 25 per cent cut-off. The distance from the steam edge to the exhaust edge on the valve over the packing rings is 2¾ in., therefore the similar ellipses which are plotted 2¾ in. above and below the center ellipse with lighter lines must represent the movement of the exhaust edges of the valve. The three ellipses shown in dotted lines represent the movement of the valve set with no lead in full fore gear. Picking out the valve events we find that with the ¼ in. lead setting we have the cut-off at 23 in. and 23⅞ in., the release at 25 9/16 in. and 26¼ in., and the closure at 26 13/16 in. and 27¼ in. Set with no lead however, we have the cut-off at 23 9/16 in. and 24⅝ in., the release at 26⅛ in. and 26¾ in., and the closure at 27¼ in. and 27⅝ in., so that the net result of adopting this latter setting is to delay the cut-off from 83.7 per cent to 86.1 per cent, the release from 92.6 per cent to 94.5 per cent, and the closure from 96.6 per cent to 98 per cent, an improvement in the starting position of 2.4, 1.9 and 1.4 per cent of the stroke respectively.

"The valve diagram shown in Fig. 2 is plotted for the same engine on full back gear, the ellipse shown in dotted lines representing the valve movement with a variable lead setting, which setting is made possible by the lead slightly increasing in the forward motion, with a corresponding decrease on the backward motion. In this case there are two lines ¼ in. above and below the center line representing the amount of the exhaust clearance. These lines will determine the release and closure points in the same way that the outside edges of the steam parts did in Fig. 1.

"Fig. 3 shows the position of the crank pin of this engine at the point of cut-off, the full line indicating position with normal setting and the dotted line with variable lead setting. It is evident that when the engine is standing in this position we shall have the minimum starting effort, as all the turning movement has to come from the other crank, which will be either at Bb or Cc, according to whether Aa represents the right hand crank or the left. The effective length of the crank, which is doing the work, is 10 in. for normal setting, and 10⅝ in. for the variable lead setting, or a difference in favor of

VALVE DIAGRAM.
FULL FORE GEAR AND RUNNING POSITION

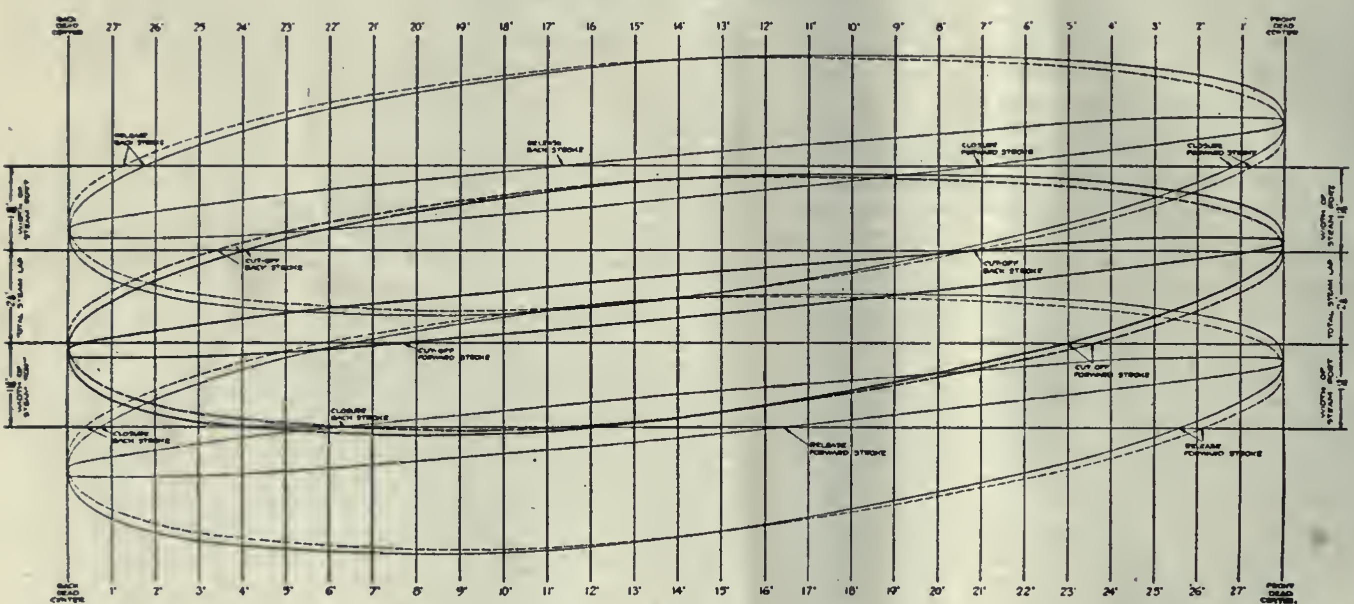


FIGURE 1.

the variable lead of 6.25 per cent, so that the minimum starting effort of this engine is increased by 6.25 per cent by this setting. The maximum traction effort is not affected in any way. As soon as the engine has turned a wheel the advantage almost entirely disappears.

"Fig. 4 shows a diagram plotted for one of our Mikado engines. This engine has cylinders 27 by 30 in., 14 in. valve, 6½ in. valve travel, ⅛ in. constant lead, 1 in. steam lap, and no exhaust clearance. The reduction or total elimination of the exhaust clearance lengthens the period of expansion by delaying the release, and this in itself is a good feature, but it has also the effect of advancing the closure point and the question naturally arises as to why it should be permissible to eliminate exhaust clearance and thus advance the closure point on freight engines and not on passenger engines. The first reason is that in running position the passenger engine is generally notched up to a much earlier cut-off than the freight engine,—about 25 per cent of the stroke instead of 50 per cent,—and the second that the piston speed of the passenger engine averages much higher than that of the freight engine.

"The passenger engine under consideration, has a piston speed of 1136 feet per minute when making 50 miles per hour, or over 40 per cent higher than that of the freight engine at 30 miles per hour, and the higher the speed the higher the compression will be, provided that all other conditions are equal. By giving this engine exhaust clearance we not only delay the closure point but also give a greater exhaust part opening, thus allowing the exhaust freer access to the atmosphere, and the result is a freer running engine. It may be imagined that when the engine is working at a short cut-off less steam is admitted to the cylinder, and, therefore, the piston has less to sweep out on the return stroke, but the exhaust begins with the release, and by the time the return stroke has begun there is very little difference in the amount of steam left in the cylinder, whether running on long or short cut-off.

"From the point of view of economy the question of steam consumption per unit of power developed, the higher the compression the greater the economy, provided we do not run the compression higher than boiler pressure. This is on account of the clearance volume, and we can readily understand that the higher the compression the less steam has to be supplied from the boiler to build up the initial pressure, and if the compression reaches boiler pressure there is no steam drawn from the boiler until the piston actually starts its working stroke. The next thing to consider is the power required, as it is no use trying to run on a very fine thread of steam if we cannot get the tractive effort necessary to keep the load moving.

"If we compare Figs. 1 and 4 we find that the closure takes place at 76 per cent of the stroke for the passenger engine in running position; with the freight engine running at the same cut-off the closure takes place at 73 per cent, but if we eliminate the exhaust clearance on the passenger engine we shall advance the closure point from 76 per cent to 68 per cent of the stroke which is a marked advantage in point of economy.

"This goes to show how much the closure point is affected by the amount of exhaust clearance. For my own part I do not think the actual closure point is of very much importance, but that the exhaust port opening has a great deal more influence on the compression than the actual position of the closure point. I contend that if we pay proper attention to the exhaust port opening the closure point will take care of itself. There is no purely mathmetical means of determining the most desirable exhaust port opening, and this, like so many other problems in locomotive work, has had to be determined by practical experiments.

"It is here that we find the chief difference between passenger and freight engine setting, and, still referring to Fig. 1 and 4, we see that the maximum exhaust port opening in running position for the passenger engine is just over 1⅝ in.,

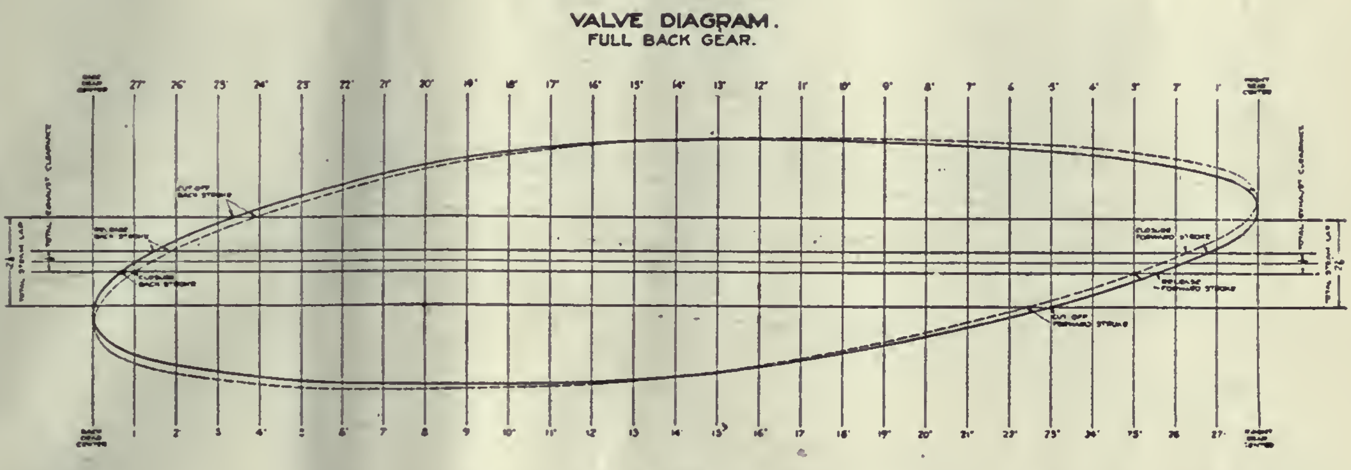


FIGURE 2.

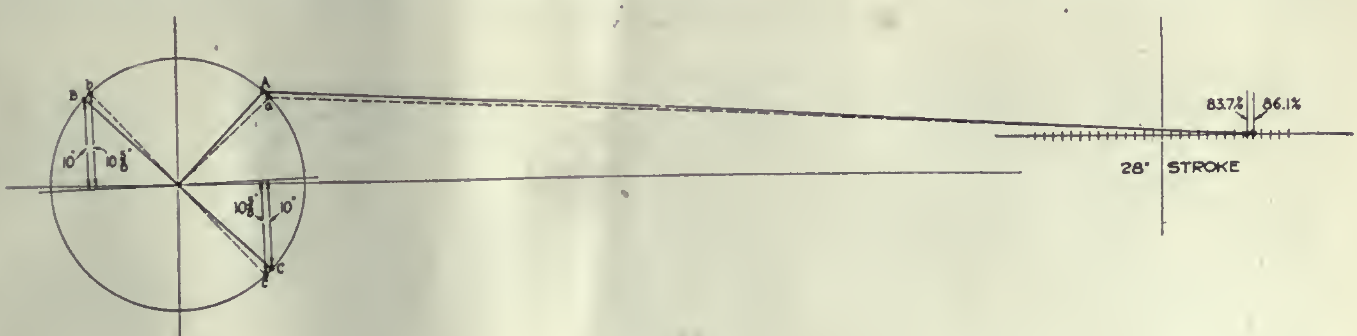


FIGURE 3.

whereas that of the freight engine is just over 1 9/16 in. when running at a 50 per cent cut-off, while if we notch up the freight engine to the same cut-off as the passenger engine we have a maximum exhaust port opening of only 1¼ in.

"This maximum port opening is only maintained for a few inches of the stroke, and it is easy to understand that when this port opening begins to narrow down it will form quite a choke for the exhaust at a high piston speed, and will build up quite a little compression before the closure point is reached. We all realize that a locomotive exhaust has to be choked to a certain extent to obtain a high velocity jet up the stack which will induce a proper draft through the grates, but this choking should be done by the exhaust pipe tip and not by the valve. The area of the exhaust pipe on the passenger engine under consideration is about 23 sq. in., and on the freight engine 29 sq. in., and the valve displacement necessary to give a part opening equal to the area of the tip will be approximately 11/16 in. for the Pacific engine and ⅞ in. for the Mikado. This 11/16 in. port opening is maintained for 53 per cent of the stroke on the Pacific engine, but on the Mikado the ⅞ in. port opening is only maintained for 36 per cent of the stroke when notched up to the same cut-off as the Pacific. When the Mikado is running at 50 per cent cut-off, which is approximately the running position, the ⅞ in. exhaust port opening is maintained for 58 per cent of the stroke, which compares favorably with the Pacific. This gives us the chief reason why the Pacific setting is found to be more suitable for high speeds and short cut-offs, while the Mikado setting is better on the slower speeds and long cut-offs. From these comparisons we can see that the passenger engine setting has been developed to give a smart and free running engine at high speeds and short cut-offs, while the chief consideration with the freight engine setting is to obtain the greatest possible traction effort at moderate speeds and to run on comparatively long cut-offs with the greatest economy by delaying the release point as far as possible."

VALVE DIAGRAM.
FULL FORE GEAR. 50% AND 25% CUT-OFF.

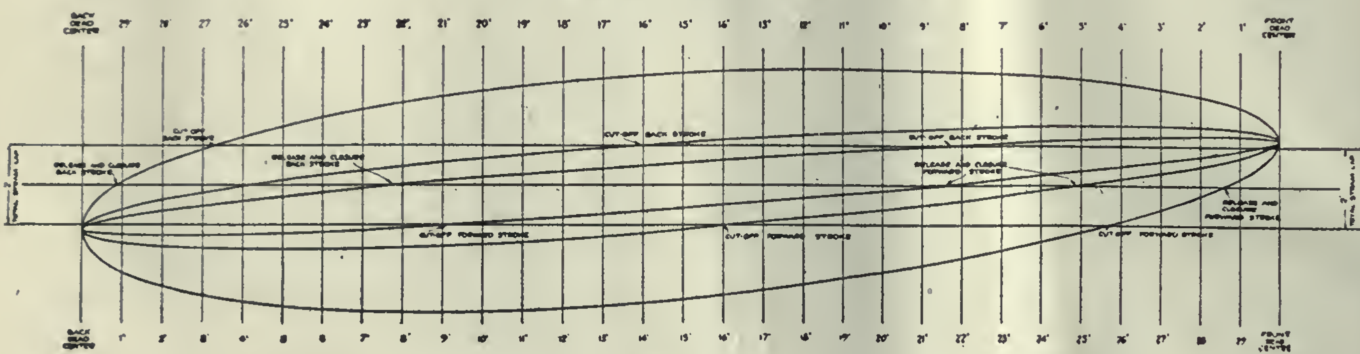


FIGURE 4.

New Application of Piston Valves to Slide Valve Cylinders

By J. Snowden Bell

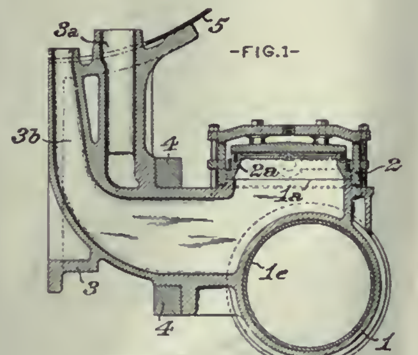
Much attention has, of late, been very properly paid to the continued utilization of locomotives which, by reason of comparatively antiquated construction, have been found to be incapable of satisfactorily meeting the requirements of present service conditions, this continuance of service being attained by *"modernizing"* them, by the addition of new appliances, and the substitution of devices of more recent and perfected design for those which were originally applied on the locomotives. These changes have been, principally, the application of superheaters; the substitution of radial valve gears and piston valves for Stephenson link motions and slide valves; and that of outside for inside steam pipes. Feed water heaters have not, as yet, in the United States at least, established such a record of efficient and economical service as would bring them to general adoption, but from information as to the results of a new design, for a considerable period, the writer feels confident that this feature will soon become an accepted and important one.

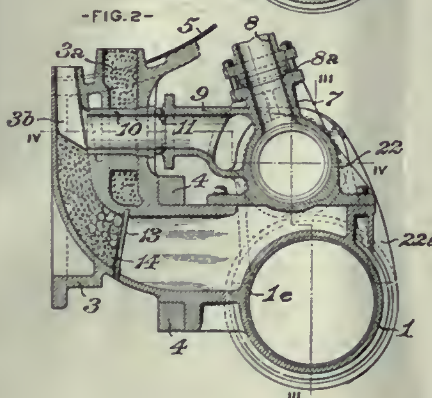
The application of piston valves to slide valve cylinders, by the use of an additional valve chest for a piston valve, fitted inside the chest of the original slide valve, was made at a comparatively early date. The earliest complete illustration which the writer has been able to develop, is that made by Thomas S. Davis, of Jersey City, N. J., which is fully shown and described in London *Engineering,* June 22, 1866, page 411, and a design, on the same principle, also appears in the United States Patent of A. R. Morrill, of Northfield, Vt., No. 22192, dated November 30, 1858. Piston valves are said to have been applied on a slide valve engine of the Boston & Worcester R. R., about the year 1860, and these may have been on the Morrill plan, but no record of them seems to have been preserved.

The early practice referred to, appears to have been discontinued until a comparatively recent period, when several detail designs of piston valves and chests, applied to slide valve cylinders, were patented and put on the market to some extent, among these being those commercially known as the "Universal," the "Simplified," and the "Modern." This method of application is distinctly and materially advantageous, in avoiding the large expense of scrapping existing cylinders and their connected half saddles, but is subject to the objection of involving the use of detachable valve chests, of bottom dimensions as large as those necessary with slide valves, and having joint wires interposed between them and the cylinder faces. With chests of such character, assuming the uncertain possibility of applying them without distorting or disturbing the joint wires, there remains the inevitable stretching of the fastening bolts in service, and, as often as these are tightened, the valve chests and valve stem are correspondingly thrown out of alignment.

A new and entirely practical method of

converting inside steam pipe slide valve locomotive cylinders into outside steam pipe piston valve cylinders, which has been devised and patented by Mr. Patrick Sheedy, superintendent of motive power of the Southern Pacific System at Los Angeles, Cal., and put into practice by





him on thirty locomotives of that system, and four of the San Diego & Arizona Ry., is here illustrated. This method, briefly stated, consists in cutting circumferential end recesses in the cylinder, fitting a piston distribution valve chest thereon and engaging it therewith, by legs on the chest, entering the end recesses of the cylinder, and securing the valve chest and cylinder together, by shrinking bands around them. The joints between the legs of the valve chest and the cylinder, which are the only ones at which steam leakage could take place, are covered by the cylinder bushing, and such leakage is therefore completely prevented, without the use of joint wires or other packing.

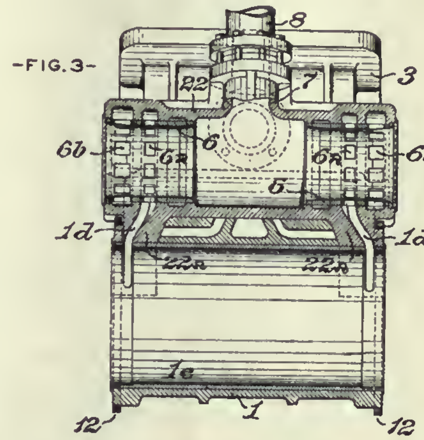
As will be seen from Fig. 1, which is a middle transverse section, the cylinder which was converted, was originally fitted with a slide valve, working in a detachable chest, of the ordinary form, taking steam at the ends of the chest, through an inside steam pipe, and exhausting through a passage at the middle of the chest. The cylinder had the long induction and eduction passages common with slide valves, which are blocked when the conversion to a piston valve cylinder is made, as shown in Fig. 3.

Fig. 2 is a section, taken in the same plane as Fig. 1, showing the converted cylinder and its piston valve chest. The former end steam passages are closed at their tops by caps or plugs, and a suitable filling composition, as a mixture of cement and iron borings, concrete, etc., is inserted. An outside steam pipe, of the usual design, is connected to a nozzle at the middle of the valve chest, for supply to an inside admission piston valve, and end exhaust passages lead to a side nozzle which is connected to the original exhaust passage near its top. Below this connection, filling material is inserted in the unused portion of the exhaust passage, as shown.

The manner of fitting the valve chest legs into the end recesses of the cylinder, connecting the valve chest and cylinder by shrinking on bands at the ends, and covering the joints by the cylinder bushing, is clearly shown in Fig. 3, which also illustrates the direct induction and eduction ports of minimum length, which are substituted for the original long ones. The resultant substantial advantage, in reduction of clearance, will be obvious. The cost of converting an inside steam pipe slide valve locomotive to an outside steam piston valve locomotive, by the Sheedy system, is approximately $650, or about 20 per cent of the cost of applying new piston valve cylinders.

Engine No. 26 of the San Diego & Arizona Ry., which is shown in Fig. 4, is one of four which were converted, by the method above described, and under the direction of Mr. Sheedy, from saturated slide valve inside steam pipe to superheated piston valve outside steam pipe engines. They were built by the Baldwin Locomotive Works, and have 21 x 26 inch cylinders, and 63 inch driving wheels, with 144,000 pounds on driving wheels, and are operating very successfully on 2.2 mountain grades, between San Diego and Imperial Valley, Cal. Thirty Baldwin 2-8-0 type engines of the Southern Pacific System have also been converted by Mr. Sheedy's method at the Los Angeles shops of that system.

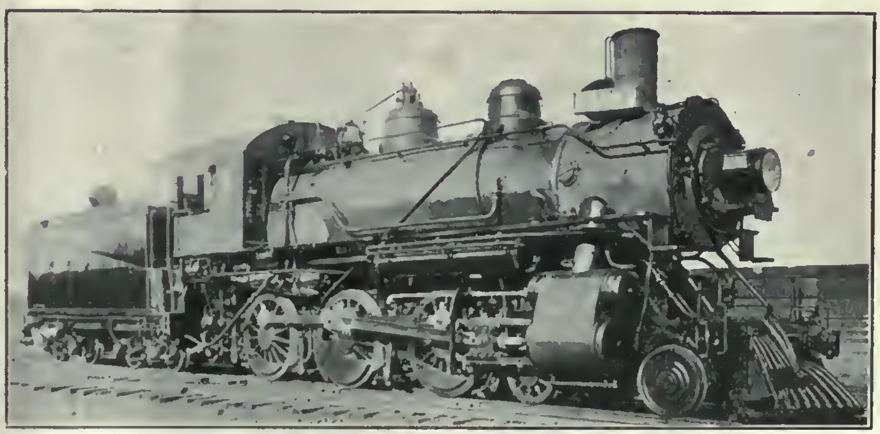
A consolidation engine was converted for comparative test purposes, and placed in service in March, 1919. This engine is using saturated steam, and is the same as originally, except as to difference of distribution valves and steam pipes. It has shown an average saving for the year of over 15 per cent largely due to the economy resultant on reduction of clearance. The engine has made, for the past year, 14,853,100 ton miles, and saved ap-



proximately 27,986 gallons of fuel oil, over the average of the engines of the group from which it was taken. The money saving would, of course, be in proportion to the cost of oil where the performance was made.

The Cost of the Strike.

The strike is costing the railways many millions in fares and freight charges; it is costing the strikers themselves millions in wages; it is costing millions by holding up perishable food; it is costing millions by delaying shipments of raw stuffs and so injuring industry; it is costing millions by crippling the passenger services and keeping men and women from their accustomed work; it is threatening to cost still other millions by bringing on the disaster of a fuel famine.



NO. 26, SAN DIEGO & ARIZONA RAILWAY CHANGED FROM SATURATED SLIDE VALVE INSIDE STEAM PIPE TO SUPERHEATED PISTON VALVE OUTSIDE STEAM PIPE LOCOMOTIVE

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The Transportation Disturbance.

The deplorable strike among certain classes of railroad men that has resulted in a detached paralysis of transportation has been so fully described and discussed in the daily press that there is little left for the engineering press to do than try to discover, if possible, the reasons that have led to a condition so full of real disaster to the best interests of the public generally. Among the causes, perhaps, is the fact that certain classes of railroad workers have had a greater degree of consideration in the need of increased remuneration than others. In the very nature of things this was to be expected, and nothing approaching a horizontal increase has been achieved or aimed at. The most clamorous are usually the most heeded, and those also who are nearest to the ear of the adjudicating authorities are in a better position to be listened to than those who are more remote from the seat of power. In this regard the organized railroad bodies have had no great cause of complaint. The heads of the various brotherhoods have shown themselves ably qualified to present their claims in such a way as to receive prompt attention, and the result has been a certain amount of consideration with a measure of remedial relief, and the assurance of a further hearing of their claims, and in view of these facts a spirit of patience, lit by a feeling of hopefulness, was to be expected.

In the face of this condition the tie-up of last month seems unjustified, and we must look elsewhere if we hope to find the causes of this spirit of unrest, and the thought comes to us that the problem is one that should rather engage the serious attention of our statesmen, if there be such amongst us, than those who are merely desirous of advancing the welfare of those among whom we live and move and have our circumscribed being. It looks to us like a lack of forethought that on the return of the railroads to their owners the Arbitration Board whose duty it is to give a prompt hearing to complaints from any considerable number of railroad men and which appointment formed part of the mandatory regulations embodied in the law bearing upon the subject was not named. The prompt appointment of the board would have established a court of appeal and might have precluded the disaster. This thought is strengthened by the fact that the appointment of the Board promptly followed the outbreak of the discontented employees and looks to be a sudden step to provide means of conciliation after a trouble had begun rather than a mere coincidence. It is easier to check a rebellion than put one down. The first belongs to the realm of statesmanship, the second to the force of arms.

While such a strike at such a time and the consequent recriminations involved has its dark side, it has also its bright side. The integrity of the railroad brotherhoods, at first doubted, is now beyond suspicion. We feel morally bound to believe their serious statement that "there can be no settlement of pending wage questions while this illegal action lasts." It therefore becomes immaterial from what causes the action of the strikers has come. The proceedings towards a settlement must be along legalized lines that have been accepted or, at the last analysis, enforced.

Not only so but anything else strikes at the root of the organic structure upon which representative government rests, and it is well at all times and particularly at a time like the present to recall the wise words of George Washington:

"It is of infinite moment that you should properly estimate the immense value of your national union to your collective and individual happiness; that you should cherish a cordial, habitual and immovable attachment to it: accustoming yourselves to think and speak of it as of the palladium of your political safety and prosperity; watching for its preservation with jealous anxiety."

Fire Prevention.

In recent years the losses by fire directly traceable to the railroads has greatly diminished, owing to the fact that nearly all of the division points and many of the lesser sub-divisions have excellent equipment ready to meet an emergency. To this is superadded trained squads of men that are drilled occasionally and know how to act when occasion calls. At many points special fire engines and hydrants are ready under the supervision of specially trained men. A few recent fires, however, call attention to the fact that fires are more frequent in buildings in the winter time, especially when the water supply may be menaced by severe frosts. This danger, however, has been met to a considerable degree by a mixture of calcium chloride in the water tanks and barrels which lowers the freezing point of the contents. Common salt may also be used, although less effective in its resistance to freezing, 3½ lbs. of calcium chloride per gallon of water preventing the freezing of water to about 20 below zero, while the same quantity of a salt solution in a gallon of water will freeze at about 8 below zero.

More recently, however, it has been found that congestion of cars in yards renders it particularly difficult to handle the fire equipment in case of fire breaking out in a yard. Frequently there is no yard engine or other locomotive either to clear the track of dangerous loads, or to move cars, the presence of which impede and hamper the firemen at their work. Occasionally long lines of water hose have to be laid, where, if free access to the fire could be had, chemicals might readily quench the fire. Delayed action, especially in cases of lumber car fires where a start has been secured, the result is that the car is either burned beyond repair, or seriously damaged.

Chemical tanks carrying about 40 gallons, and the largest water tank possible should be part of terminal and yard equipment. At each terminal a car should be stationed carrying the chemical tank and 500 feet of hose; also a water tank and motor pump with sufficient capacity to allow at least 500 feet of water hose to be used. Axes, ladders long enough to reach the eaves of the tallest buildings, pike poles and chemical extinguishers of the largest hand type, should form the chief part of the equipment. The tank should be kept full, and in case of fire when the contents have been diminished, the tank should be promptly refilled and be made ready for action again. A gasolene motor should be used to run the car's pump, and if possible the car should be kept in the middle of the yard so as to have the shortest possible run both ways. The car might also be equipped with a light hose reel, as extra lengths of hose may be required. Such an outfit could cover a radius of fifty miles, and in case of a yard or terminal fire would, if not entirely effectual, at least hold the fire until more powerful means arrived.

At isolated stations, and at fires along the right-of-way, and for the protection of trestles and bridges the tank car would prove valuable. Bicarbonate of soda added to the tank water supply would greatly increase its efficiency. About 4 ounces per gallon of water has been found sufficient. In cities, or their outskirts, it is usual that the superintendents of railway divisions or yard masters, should be in communication with the city fire chief, and have arrangements made for the promptest methods of clearing a way through the yard so that the city fire department could pass through.

The number of fire cars should be such as to afford protection of stations, rights of way and express sheds, trestles and bridges. In addition to the car to which we have already referred, there should be a car equipped with a heavy runway, skids and wheel blocks for carrying city motor apparatus called for by neighboring towns when the fire is too great for the local department. The apparatus should be run directly upon the car, the wheels blocked and the car started immediately. All equipment should be standardized.

We recently described in detail the best methods of handling cases of spontaneous combustion of coal, but in the piling of coal it may be added that a cement floor sloping to a center drain is advisable. If at all possible coal should be stored under cover, and heavy coal supply and wood piles or sheds should be at least 50 feet away from stations and situated so that in case of fire the prevailing winds will not blow embers, brands or sparks into station or other property.

Loading platforms are usually set up from the ground and the drafts from the trains blow papers and other inflammable material under them. Sparks from locomotives are very liable to be blown under the platform, especially if the train in running into a head wind. The space under the platform should at all times be kept clean and free from debris. The spaces between the platforms and the tracks are also liable to the same hazards, and frequently oily waste, grease and papers drop there. The latter may become oil-soaked, and subject to spontaneous combustion, or a hot coal bounding over the rail from the fire box of the locomotive, will cause a fire which will rapidly be sucked in under the station and any open space makes a horizontal chimney. A stove is also a great source of fire. It should be tight, thoroughly braced and protected underneath by metal backed with asbestos, extending at least 12 inches out on all sides from the legs and door of the stove.

The oil house sides and roof should preferably be protected by metal and the floor should be of concrete or some other non-inflammable material. Special attention should also be given to the heating and lighting facilities, and to flues and waste baskets which should be of wire and frequently emptied. Strict watch should also be kept of lofts either vacant or otherwise. All lamps and switch lights should be filled in daylight; the presence of a lighted lamp of any kind at such a time is nothing short of courting disaster.

Here precautionary comments could be added to extensively, but to the experienced railroad man there is not much that is new that could be said, but it will be admitted even among themselves that with good equipment to meet fires, and the long periods of absence of any need of the equipment, a growing spirit of indifference on the subject naturally arises, and as, in the very nature of things, a fire breaks out unexpectedly, like the breaking out of a great war, there is always a clamor about unpreparedness, and another clamor about reorganization, with all its consequent recriminations, to be succeeded by another gradually enervating period of partial neglect until the evil moment comes again, like a thief by night. Perhaps there is no class of men in the world whose abilities are more constantly called upon to meet the necessities of the passing moment than the railroad men, and that they find time at all to think of the undiscovered future, should be a matter more of agreeable surprise than of dwelling upon what might have been done. Some of us are wise in our own conceit, and nearly all of us are wise after the event.

Peat Helped by Coal.

Recent experiments in Great Britain have shown that the use of peat fuel can be greatly improved by being mixed with coal in proportions varying from 25 to 40 per cent. The heat-producing value of the coal is said to be increased by the more gradual liberation of the combustible gases, and coal is economized to the extent of the percentage of peat used. In the experiments so far made it has been noted that smoke has been reduced to a minimum, and clinker and ash deposits have been much less than from coal when used alone.

As already noted in our pages, extensive experiments are being made under the auspices of the Canadian Government in regard to the use of peat, and doubtless some real economical advance will be made in the near future.

Pulverized Coal.

The growth of the system of furnace firing with pulverized coal has been very rapid in the United States for the last few years. One company manufacturing the necessary apparatus sold its produce to 42 furnaces in 1915, to 70 furnaces in 1916, and to 386 furnaces in 1917. All coals may be burned in the pulverized form, the most suitable are those which contain more than 20 per cent of volatile matter and less than 12 per cent of ash. With lean coals and anthracite, ignition is slow. For a given quality of coal, facility of ignition increases with the fineness of the grinding. The common rule is that 95 per cent shall pass through a 100-mesh sieve and 85 per cent through the 200-mesh sieve, i. e., 100 and 200 meshes to the linear inch. To obtain complete combustion, and to ensure regular working, the coal must be dried to within one per cent of humidity. Necessary conditions of satisfactory working are:—(1) that the coal must be mixed with air before entering the combustion chamber; (2) the velocity of the jet of coal and air must not exceed 25 metres per sec.; (3) the volume of the combustion chamber must be determined for each case, this condition being particularly important in the case of a boiler installation.

Railway Supply Men's Exhibit at Atlantic City.

The Executive Committee of the Railway Supply Men's Association report that the application for exhibit space has been largely in excess of the amount of space available, the report showing that 350 exhibitors have been allotted space this year, the number last year being 301. Efforts are being made in many cases to find limited space for applicants with those exhibitors who have already secured space. There is every indication of the attendance being larger than that of last year, when the presence of the administration officials was presumed to be an added attraction to the occasion.

American Society for Testing Materials.

The annual meeting of the above society will be held at the New Monterey Hotel, Asbury Park, N. J., on June 22-25 inclusive. Since last meeting 401 new members have been added to the roll, and the meeting promises to be the largest in the history of the society. Among the subjects on which special committees will report are, "On Non-Ferrous Metals," "On Wrought and Malleable Iron and Corrosion;" "On Steel;" "On Testing Apparatus;" "On Preservative Coatings and Lubricants;" "On Road Materials, Lime and Gypsum," and "On Cement and Concrete." The following nominations for officers will be submitted by the nominating committee: for president: George S. Webster. For vice-president: George K. Burgess. For members of executive committee: L. G. Blackmer, D. E. Douty, Prevost Hubbard and R. S. Whiting.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page* 115, *April*, 1920.)

1171. Q.—What is the object of the projection at the end of the diaphragm stem?

A.—To make a fit in the seat of the diaphragm stem, so that any jar which would momentarily unseat the diaphragm stem could not result in a blast of the signal whistle.

1172. Q.—In what way does it prevent the signal whistle from sounding?

A.—By restricting the escape of signal line pressure to such an extent that the reduction is insufficient to move the diaphragm.

1173. Q.—What is the effect of removing this projection?

A.—With the signal system practically free from leakage, the whistle will sound every time the engine receives a rough jar, or the signal whistle will sound if the signal valve is tapped with a wrench or hammer.

1174. Q.—Is the signal system ever affected by the condition of the distributing valve?

A.—Yes.

1175. Q.—In what manner?

A.—With a badly worn application cylinder bushing or a poor fit of application piston packing ring, friction developing in the application portion sometimes results in an overcharge of the signal system when the brake is applied.

1176. Q.—How is this accounted for?

A.—By leakage from the main reservoir through the brake cylinders, into the application cylinder and through the independent brake valve into the signal system.

1177. Q.—Why is it poor practice to fit packing rings in triple valves?

A.—By the time a packing ring is worn out, the bushing will also be worn to some extent, and a packing ring cannot be correctly fitted to a worn bushing.

1178. Q.—What does the extensive fitting of packing rings in triple valves result in?

A.—To a great extent in the large number of cases of stuck brakes and slid flat wheels that are encountered in both freight and passenger service.

1179. Q.—What causes a distributing valve to make a loud rumbling noise when it applies?

A.—Generally too loose a fit of the collar of the application piston in the cavity in which it operates.

1180. Q.—Does anything else ever cause this?

A.—Sometimes it is the result of a very weak application piston graduating spring or a broken or missing exhaust valve spring, or a badly worn lug or spider at the end of the application piston.

1181. Q.—What makes the rumbling noise?

A.—The application piston and attached valves traveling rapidly from application to lap position, sometimes to partial release position and return.

1182. Q.—How is the difference between the worn parts mentioned, or the broken springs distinguished?

A.—With the application piston graduating spring or the exhaust valve spring broken or missing the rumbling noise is usually accompanied by short exhausts from the distributing valve exhaust port, but as a result of the worn parts, there is usually no escape of air from the distributing valve.

1183. Q.—What is indicated by an intermittent exhaust after the brake is applied?

A.—A leaky application valve.

1184. Q.—What would be indicated if the brake on an engine was operating correctly until at a certain time an application was made and the brake could not be released with either brake valve, there being air pressure in the brake cylinders?

A.—It would indicate a broken application piston that had left the exhaust valve and application valves in application position.

1185. Q.—Is this of frequent occurrence?

A.—No; it is seldom encountered, but occasionally the application piston is in some way fractured and the piston breaks off from the stem.

1186. Q.—What are the principal tests that are to be made on a test rack after a distributing valve has been thoroughly cleaned and repaired?

A.—The principal tests are for undue frictional resistance to movement and leakage.

1187. Q.—With 80 lbs. air pressure, the standard used for test rack operation, how long should it take to charge the pressure chamber from 0 to 70 lbs.?

A.—From 55 to 75 seconds.

1188. Q.—What is wrong if a longer time is required?

A.—The feed groove in the piston or in the piston bushing is partly obstructed, is not of the proper size or there is some leakage from the pressure chamber or its connections.

1189. Q.—What if the time is considerably shorter than 55 seconds.

A.—It indicates additional leakage into the pressure chamber, presumably past the equalizing piston packing ring, or that the feed groove is enlarged.

1190. Q.—To avoid guess work about the capacity of the feed groove or the charging time of the pressure chamber, what should be noted before the test is attempted?

A.—That there is no leakage from any part of the distributing valve to the atmosphere or from the brake valve exhaust port.

1191. Q.—What is indicated by a discharge from the vent port with all valve handles and lever in the proper position?

A.—An excessive amount of friction in the equalizing portion.

1192. Q.—How is a release test made?

A.—With the differential valve pressure in the reverse order and with a fixed rate of feed up into the brake pipe.

1193. Q.—Does the differential valve action then indicate excessive friction?

A.—Yes, if the vent port opens the brake pipe pressure has exceeded the pressure chamber sufficiently to raise the diaphragms with the weights attached without moving the equalizing piston and slide valve to release position.

1194. Q.—How is the service port tested for capacity?

A.—In two tests with two different rates of brake pipe reduction, one of which shall, and the other which shall not, produce quick action.

1195. Q.—How is excessive friction in the application portion manifested?

A.—By a difference of more than 3 lbs. pressure between the brake cylinders and the application chamber while the brake is being graduated on and off with the independent brake valve.

1196. Q.—How is a test made for application piston packing leather leakage?

A.—By closing the stop cock in the supply pipe, placing the independent brake valve handle in slow application position, then closing the brake cylinder stop cock.

1197. Q.—Where is the leakage past the leather then shown?

A.—By an increase in the pressure shown on the brake cylinder gage.

1198. Q.—How is the application piston ring tested for leakage?

A.—By re-opening the cocks, applying the brake in full with the independent brake valve, plugging the distributing valve exhaust port and moving the independent valve handle to running position.

1199. Q.—Where is the amount of leakage shown?

A.—From a blow from the exhaust port of the automatic brake valve, or by a build up in the application cylinder if the independent or automatic valve is moved away from running position.

1200. Q.—If during a test, the application portion is sufficiently sensitive, how many graduations in brake cylinder pressure can be made with the independent brake valve from an original 45 lbs. pressure?

A.—At least 4 can be made before brake cylinder pressure is entirely exhausted.

(To be continued)

Train Handling.

(Continued from page 116—April, 1920.)

1209. Q.—What portions does the universal valve consist of?

A.—A pipe bracket, an equalizing portion, a quick action portion, a high pressure cap and a magnet bracket portion.

1210. Q.—What is the pipe bracket?

A.—The base or fixture on which the universal valve portions are mounted.

1211. Q.—What chambers does it contain?

A.—A quick action chamber and a quick action closing chamber.

1212. Q.—What are the pressures stored in these chambers used for?

A.—To open and close the quick action valve during quick action or emergency operation.

1213. Q.—What is the principal use of the equalizing portion?

A.—To control the service operation of the brake.

1214. Q.—What parts does it contain?

A.—An equalizing piston, slide valve and graduating valve, a release piston and slide valve, 3 ball check valves, a charging valve and a graduated release piston.

1215. Q.—What parts does the quick action portion contain?

A.—An emergency piston, slide valve and graduating valve, a quick action piston, a quick action valve and one ball check valve.

1216. Q.—What does the high pressure cap contain?

A.—An intercepting valve, a protection valve, a high pressure valve, a safety valve, a cut off valve, a ball check valve and an emergency piston stop.

1217. Q.—The magnet portion?

A.—Service, emergency and release magnets and valves, an emergency piston and switch and a magnet valve cut out cap.

1218. Q.—What reservoirs are essential?

A.—An auxiliary, service and emergency reservoir, when a high emergency braking ratio is desired.

1219. Q.—What if a low emergency braking ratio is desired?

A.—The proper size of reservoir is added for the brake cylinder in emergency operation, and the large emergency reservoir is termed a quick recharge reservoir.

1220. Q.—With the 4 reservoir arrangement how are the reservoirs sometimes designated?

A.—As the large and small emergency reservoirs.

1221. Q.—What is the large reservoir used for?

A.—Quick recharge, graduated release, if desired, and for a high pressure in the brake cylinder for emergency operation.

1222. Q.—And if two emergency reservoirs are used?

A.—The large reservoir is for the quick recharge, graduated release, if employed, and the smaller emergency reservoir is used for the additional brake cylinder pressure in emergency.

1223. Q.—How is the emergency braking ratio governed with the 4 reservoir installation?

A.—By the size of the small emergency reservoir.

1224. Q.—What is the service reservoir used for?

A.—To store a supply of compressed air for the brake cylinder in both service and emergency operation.

1225. Q.—With no air pressure in the reservoirs, how is the auxiliary reservoir charged?

A.—From the brake pipe through a feed groove in the equalizing piston bushing.

1226. Q.—How is the large emergency or quick recharge reservoir charged?

A.—Through a separate port leading from the equalizing piston chamber through the release slide valve bushing to the reservoir.

1227. Q.—What prevents a back flow from the large reservoir when a brake application is started?

A.—A ball check valve in the charging port.

1228. Q.—How is the service reservoir charged?

A.—From the release slide valve chamber (quick recharge or large emergency reservoir pressure) through the charging valve.

1229. Q.—How is the small emergency reservoir charged?

A.—Through a feed groove in the intercepting valve bushing, from the quick recharge reservoir.

1230. Q.—What prevents a back flow from the quick recharge reservoir into the service reservoir through the charging valve when a brake pipe reduction is made?

A.—When the auxiliary reservoir pressure lowers through expansion into the brake cylinder, the charging valve moves to its lower position separating the two reservoirs.

1231. Q.—What is the pressure in the equalizing slide valve chamber?

A.—Auxiliary reservoir pressure.

1232. Q.—In the release slide valve chamber?

A.—Large emergency reservoir or quick recharge reservoir pressure.

1233. Q.—How is the quick action and quick action closing chamber charged?

A.—From the brake pipe through a restricted opening leading to the emergency piston chamber, then through a separate port containing a ball check valve.

1234. Q.—What is the object of the ball check valve?

A.—To prevent any back flow from the quick action chambers when a brake pipe reduction is made.

1235. Q.—What is the object of the ball check valve in the high pressure cap?

A.—To permit of a free passage of air from the emergency piston chamber, but to restrict the flow to it.

1236. Q.—Why was this found to be necessary?

A.—The pressure increasing in this chamber so rapidly under certain conditions tended to damage the emergency piston, by moving it to its release position too rapidly.

1237. Q.—What controls the flow of air from the auxiliary and service reservoirs to the brake cylinder in service operation?

A.—The movement of the equalizing piston, slide valve and graduating valve.

1238. Q.—What controls the flow of air from the brake cylinder to the atmosphere for the release of the brake?

A.—The movement of the release piston and slide valve.

1239. Q.—What controls the movement of the release piston structure?

A.—The equalizing piston, slide valve and graduating valve.

1240. Q.—What is the service port check valve used for?

A.—To prevent a flow from the brake cylinder into the auxiliary reservoir.

1241. Q.—When could this occur?

A.—After an emergency application which has developed a higher pressure than is contained in the auxiliary and service reservoirs.

1242. Q.—The object of the service port ball check valve?

A.—To prevent any flow of air from the auxiliary reservoir into the service reservoir.

1243. Q.—When would this be undesirable?

A.—During a graduated release of brakes, or during a two application stop.

1244. Q.—What produces a movement of the equalizing piston and graduating valve?

A.—Lowering the brake pipe pressure sufficiently below that in the auxiliary reservoir.

(To be continued)

Car Brake Inspection.

(Continued from page 117)

1129. Q.—How would emergency reservoir pressure pass the service port checkvalve?

A.—By flowing through the brake cylinder.

1130 Q.—Are such troubles likely to occur with universal valves in service?

A.—Not if the valves are properly repaired and tested before being placed in service.

1131. Q.—If a brake test truck is coupled to a train of mixed UC and PM which brakes release first during the release test?

A.—The universal valves.

1132. Q.—How much of an increase in pressure is ordinarily required to effect a complete release of a universal valve operating in direct release?

A.—About 1½ lbs.

1133. Q.—What if 2 lbs. or a trifle over is required?

A.—That universal valve is very badly in need of attention.

1134. Q.—What is one of the first things to be observed when a valve fails to respond to the operation desired?

A.—To see that all of the exhaust ports are open.

1135. Q.—How are they sometimes closed?

A.—With sheet metal thread protectors.

1136. Q.—What would prevent the emergency operation of the brake, service operation being correct?

A.—A defect of the emergency piston or intercepting valve.

1137. Q.—What would likely be found wrong?

A.—That one of these parts was stuck tight in its bushing.

1138. Q.—How would the stuck emergency piston be detected?

A.—The quick action valve would not open.

1139. Q.—And if the intercepting valve was at fault?

A.—The quick action valve would open but the high emergency brake cylinder pressure would not be developed.

1140. Q.—After a universal valve has been properly cleaned and all grease and dirt removed from the various parts, what should be done?

A.—It should be given a bath in benzine or gasoline or some substance that will evaporate leaving all parts perfectly dry.

1141. Q.—What parts of the equalizing portion require lubrication?

A.—The piston bushings, packing rings, slide valves, the charging valve and graduated release piston.

1142. Q.—Should the check valves be lubricated?

A.—No they should be left perfectly dry.

1143. Q.—What parts of the quick action portion should be lubricated?

A.—The emergency piston, slide valve and graduating valve.

1144. Q.—What parts of the high pressure cap?

A.—The intercepting valve, the high pressure valve, the cut off valve and the protection valve.

1145. Q.—What about the quick action piston and safety valve?

A.—They should remain dry as well as the check valves in these two portions.

1146. Q.—Does any part of the electric portion require lubrication?

A.—No.

1147. Q.—What if instructions specify a certain grade of oil on the pistons and valves mentioned?

A.—Instructions should be obeyed, and the specified oil used very sparingly except on the slide valves and seats where dry graphite is universally recommended.

1148. Q.—Any if no special instruction exist?

A.—Dry graphite should be used on all parts mentioned for lubrication.

1149. Q.—Should a packing ring be removed for the purpose of cleaning the ring groove?

A.—Under no circumstances.

1150. Q.—Why not?

A.—Removing a ring from the groove springs it out of its original shape, and frequently enough to destroy the fit in the bushing.

1151. Q.—When should rings be removed from the piston groove?

A.—As a general proposition only for refitting or renewal of the ring.

1152. Q.—What should be done in the event of a worn piston bushing?

A.—No attempt should be made to fit a packing ring, such valves should be returned to a central shop or to the manufacturers for repairs.

1153. Q.—After cleaning and assembling is completed, what must be done before a universal valve is returned to service?

A.—It must be tested on a standard test rack built for this purpose.

1154. Q.—What amount of air pressure is generally used for testing the valve?

A.—80 lbs.

1155. Q.—After the valve is properly bolted to the bracket of the test rack, what is the first thing to be done?

A.—The stop cocks to all the reservoirs should be closed.

1156. Q.—What three tests can then be made as soon as air pressure is turned on to the rack?

A.—The protection valve opening, charging time of the quick action and quick action closing chambers, and the preliminary leakage test.

1157. Q.—What does the protection valve opening test consist of?

A.—Noting that the protection valve moves from its brake pipe to its atmospheric seat by the time 50 lbs. brake pipe pressure is shown on the air gage.

1158. Q.—What is wrong if it moves before 25 lbs. is obtained or not until over 60 lbs. brake pipe pressure is accumulated?

A.—The protection valve spring is too strong or too weak or the protection valve does not operate freely enough in its bushing.

1159. Q.—What occurs when the protection valve moves to its atmospheric seat?

A.—The quick action chamber and quick action closing chamber start to charge.

1160. Q.—What is the correct charging time from 0 to 75 lbs. with 80 lbs. brake pipe pressure?

A.—From 14 to 18 seconds.

1161. Q.—With the same brake pipe pressure, how long should it take to charge the auxiliary reservoir from 0 to 70 lbs. when the drain cock is closed and the cock in the reservoir pipe opened?

A.—In from 28 to 43 seconds.

1162. Q.—How long should it take to charge the emergency reservoir to 70 lbs. when the cock leading to it is opened?

A.—In from 65 to 80 seconds.

1163. Q.—The service reservoir?

A.—To 70 lbs. in from 30 to 35 seconds.

1164. Q.—And if a second or small emergency reservoir happens to be used?

A.—In from 43 to 55 seconds, if the auxiliary reservoir of the standard triple valve test rack is used as the small emergency.

1165. Q.—What is the maximum permissible leakage?

A.—The auxiliary reservoir pressure must not increase more than 1 lb. in 30 seconds' time.

1166. Q.—After the reservoir is recharged?

A.—Make a 10 lb. brake pipe reduction with the brake valve in position No. 5.

1167. Q.—What must be observed at this time?

A.—That the brake applies and that the emergency piston moves and discharges quick action and quick action closing chamber pressure to the atmosphere through the emergency slide valve exhaust port.

1168. Q.—What if the safety valve adjustment is incorrect and adjustment is necessary; can anything be done to retain the brake cylinder pressure and produce a more convenient test?

A.—Yes, the brake cylinder pressure can be retained by closing the exhaust port stop cock while the reservoirs are recharged for another application.

1169. Q.—What else should be observed during this brake application?

A.—That 50 lbs. brake cylinder pressure is obtained for a 20 lb. brake pipe reduction.

(*To be continued*)

How to Increase the Efficiency and Operating Capacity of Steam Locomotives*

FEED-WATER HEATER

One locomotive accessory which in my judgment stands out with surpassing and immediate importance is the feedwater heater, an instrument by means of which a portion of the heat ordinarily rejected at the stack of a locomotive may be conserved and used by abstracting this heat from either the smokebox gases or the exhaust steam, and using it for preheating of feedwater. Thus far the heat source of the more successful schemes for thus conserving the ordinarily rejected energy has been the exhaust steam. These schemes involve replacement of the injector. The injector is a 100 per cent instrument from the standpoint of returning to the boiler *all* of the heat energy delivered to it from the boiler in the form of operating or driving steam, and it does most efficiently take feedwater at ordinary temperatures and deliver it to the boiler. The energy of the steam supply is divided between elevating the feedwater temperature and imparting to it the kinetic energy necessary to drive it into the boiler, and there is practically no heat lost. Against this arrangement a saving must be represented in elevating the temperature of the feedwater by the use, not of heat drawn from the boiler, but of heat otherwise rejected at the stack, provided, of course, that the energy consumed by the mechanical operation of the feedwater heating means does not approach closely the quantity of heat caught and used instead of being rejected. A number of such means are now being currently and regularly raising the ordinary temperature of locomotive feedwater—say from 62 deg. to approximately 212 deg. Fah., or through a range of 150 deg. Fah.

Twenty or more years ago, the late M. W. Forney introduced a paper on the feedwater heater with the following statement: "To convert one pound of water of zero temperature into steam of 200 lbs. pressure requires 1231.7 units of heat: a unit being the amount required to raise one pound of water one degree. If the average temperature of water in a locomotive tender is 60 deg., then 1231.7 — 60 = 1171.7 units of heat must be imparted to it to convert it into steam of the pressure named. One per cent of that will be 11.71 units, so that if each pound of feedwater is increased that many, or, say, 12 deg. in temperature, by waste heat, before it enters the boiler, it will be equivalent to a saving of one per cent of the fuel required to convert it into steam. This is true theoretically, and has often been proved practically."

Therefore, a locomotive feedwater heater which raises the temperature of feedwater through the 150 deg. gives a fuel saving of over 12 per cent—some margin of saving upon which to work. It therefore appears that the problem of successful feedwater heating by means of exhaust steam should not involve any elaborate tests, particularly directed to the ever difficult weight and work measurement of fuel economy, but may and should be properly restricted to the mechanical performance of the feedwater heating instrument, the reduction in the cost of its maintenance and the development of assured continuity of service. We are dealing with such a large actual economy that the carriers may well afford the expenditures involved in the contribution to more definitely establishing the solution of the mechanical problem involved, without any particular concern as to the question of what may be the thermal results upon which actual savings in fuel consumption must necessarily be based; that is, they may well afford active contribution to the working out of whatever mechanical difficulties may yet have to be met by the application and use of feedwater heater equipment now available or hereafter developed for locomotive service, consistent with the assurance individually afforded by a study of the present "state of the art."

The above has been addressed particularly to the question of efficiency or economy. The question of capacity is also favorably affected in that not only is heat reclaimed from the exhaust and used, but the condensed steam as well, and to the extent that condensation is so reclaimed, it is returned to the boiler, thereby reducing the quantity of water which must be supplied to the locomotive tender for covering a given amount of work. The quantity of steam reclaimed from the exhaust figures about 15 per cent. This means that a locomotive tender of given capacity will cover an amount of work that much greater; that either the work per unit of time may be correspondingly increased or, if this work remains constant, it may be continued for a correspondingly greater distance or time. Every pound of steam reclaimed from the exhaust reduces by that amount the weight of tank water which must be evaporated.

TRAILER BOOSTER

There has been recently developed what has come to be known as a "booster," consisting of an ordinary reciprocating steam engine geared to the locomotive trailer wheels, designed for use as may be required in the starting of trains, getting them to speed the more promptly, or both, by adding to the tractive efforts ordinarily developed at the lower speeds. Its operation is controlled by air pressure. At the front end of the reverse lever quadrant is provided a manually operated latch, by means of which the booster is made "normally" inoperative or operative when the reverse lever is in the extreme forward position. With this latch in the operative position, the reverse lever, when pushed "into the corner" engages an air valve which permits air pressure to pass from the main reservoir to the booster clutch cylinder and thence to what has come to be known as the pilot valve mounted back of the boiler dome. When the main throttle is opened, a supply of steam from the dry pipe to this pilot valve causes it to permit air pressure from the booster clutch cylinder to open the booster throttle valve. When the reverse lever is pulled "from the corner" or the latch at the front end of the reverse lever quadrant is "thrown out" the booster's steam supply is cut off and the booster clutch immediately disengaged. The apparatus is, therefore, protected against damage from broken pipes, lack of air, or damage from other possible cause. When the booster is not in use, it is "out of gear" and idle, none of its parts being in operation and the performance of the locomotive then being in no way affected by reason of the booster application, but remains inactive, as already described.

Characteristic drawbar-pull and horsepower speed curves taken from dynamometer car data are shown by Fig. No. 1, from which it will be noted that the initial drawbar-pull is, by the use of the booster, increased from some 37,000 lbs. to 47,000 lbs., that the increase in drawbar-pull and the horse-power begins to diminish perceptibly at about 15 miles per hour, and that the booster becomes a load upon the regular locomotive cylinders at speeds approximating 20 miles an hour. Recalling, however, that the booster operation is discontinued by removal of the reverse lever "from the corner," it will be understood that we are assured booster interruption for quite some time before having attained even the speed of 15 miles per hour, at which the advantage in the use of the booster begins to appreciably diminish; that is, long before the diminution of this advantage occurs, and much longer before there is any possibility of the booster becoming a

*Abstract of paper read at the New York Railroad Club, April 16, 1920. By B. B. Milner, Engineer of Motive Power and Rolling Stock, New York Central Railroad.

load on the main cylinders, the booster will always have been thrown out of gear. Fig. 1 also discloses the wide margin in the ability of the boiler to supply the booster with steam, as has been count of deficiency in starting capacity and also valuable for new trailing wheel locomotives in that greater starting power and capacity may be obtained without increasing the boiler, number of driving there is only one reverse lever position or cut-off at which the locomotive will deliver its maximum in either horse-power or drawbar-pull; that is, if this reverse lever position be notch 07, cut-off 78 per

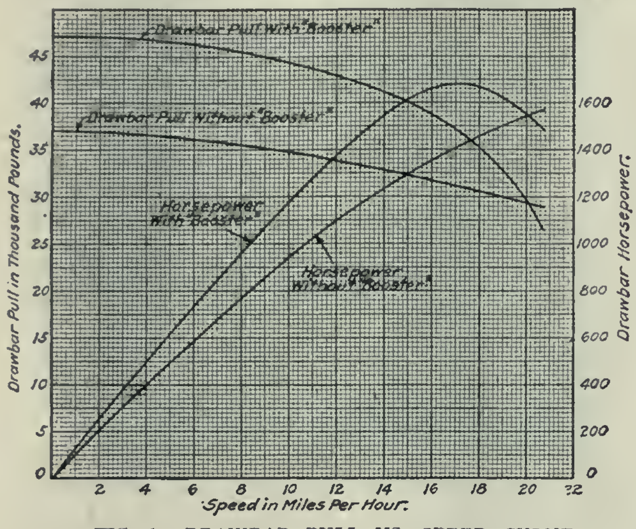


FIG. 1. DRAWBAR PULL VS. SPEED CURVE

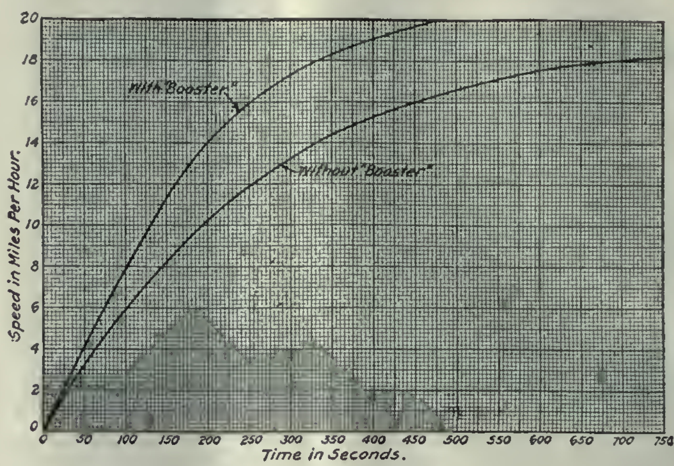


FIG. 2. ACCELERATION CURVES AND STEAM PRESSURE CURVES

NEW YORK CENTRAL CLASS K. LLE LOCOMOTIVE

proven in service, and becomes very apparent by realization of how small are the horsepower outputs from the start up to speeds at which the booster will be thrown out of gear, in comparison with the much larger horsepowers for which locomotive boilers are all amply able to supply the necessary steam.

The booster, as a means of helping existing locomotives through work which they are now only able to do with difficulty, if, indeed, they are able to do at all, will result in the satisfactory handling of larger trains, increased acceleration rates, or both. Increased acceleration should be particularly valuable to frequent-stop passenger service, and the higher initial a starting drawbar pulls and the ability to start heavier trains should be valuable to both freight and passenger services under what are now trying, if not prohibitive, starting conditions. The booster is applicable to most existing trailing wheel locomotives and should materially increase the efficiency of operation, particularly from the standpoint of the locomotive being a transportation producing instrument.

Fig. 2, however, shows clearly the advantages of the booster use from an acceleration standpoint, the train hauled being one consisting of 2,210 gross tons in 104 cars on a slightly opposing grade. Note, for example, that without the booster the speed of 16 miles an hour was obtained in 450 seconds, while with the booster this speed was obtained in 250 seconds, or in nearly 50 per cent. less time, amounting to over three minutes. The arrangement will undoubtedly prove a valuable addition to many existing trailing wheel locomotives which have become inadequate to service needs on account of deficiency ... wheels, or in materially increasing weights.

PROPER CUT-OFF FOR MAXIMUM HORSE-POWER

One of the most important factors in locomotive operation and one to which

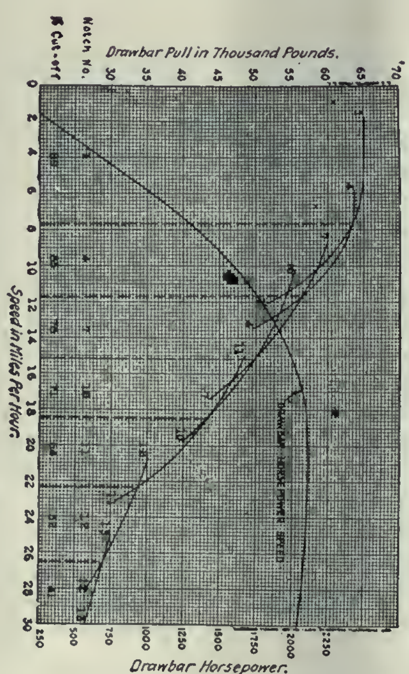


FIG. 3. COMPOSITE DRAWBAR PULL VS. SPEED CURVE

very little attention has been paid is the "science" involved in selecting the proper cut-off or the reverse lever locations required at various speeds for the development of maximum horsepower or drawbar-pull. Everyone will probably know that for any and each particular speed. there is only one reverse lever position ... cent., at say, 14 miles per hour, in any other reverse lever position and at any other cut-off, either greater or less, the locomotive will not deliver the maximum at this speed. But how do enginemen actually select various reverse lever positions at various speeds, or how have they been taught to select them when maximum horse-power or drawbar-pull output is desired or actually required in order to go through a "tight" situation either on account of the liability of "sticking" or of failing to make satisfactory time. I suggest that to have done so little for enginemen in this connection is, to say the least, somewhat of a reflection. To spend time and money in the arrangement and design of a locomotive which in these days of "high living costs" represents an investment of, say, $60,000 or more, and then turn such an engine over to enginemen to run "catch as catch can," so far as concerns cut-off selection, is not very creditable.

The graphic chart, Fig. 3, shows the general relations existing between speeds and the drawbar-pulls developed by the use of the various constant cut-offs as represented by reverse lever notches, numbered 1, 4, 7, 10, etc., consecutively from the most forward or longest cut-off reverse lever position. In accordance with facts, this chart indicates that initial drawbar-pull at zero speed, or when starting, decreases with decreases in the cut-off used; that is, a longer cut-off will develop a higher initial drawbar-pull, whereas a shorter cut-off will develop a correspondingly lower initial drawbar-pull. This chart also indicates that at successively higher speeds, successively shorter cut-offs develop maximum drawbar-pulls, or in other words, for any speed there exists a definite cut-off at which the drawbar-pulls will be maximum and the selection of any other than the "maximum drawbar-pull cut-off," either higher or lower, will develop a lesser drawbar-pull.

It becomes, therefore, apparent that some knowledge of the precise cut-offs or reverse lever positions, which at various speeds will result in the development of the desired maximum drawbar-pull, must obtain and be used if maximum results are to be secured. There remains the problem of how the necessary cut-off-speed-drawbar-pull data may best be obtained, and having obtained it how use may be made thereof.

Pulverizing Equipment of France.

The use of pulverized coal for furnaces is just beginning to find application in French industries. This is strictly an American development, and mills specially built for pulverizing coal have been ordered from the United States by the pioneer French coal-pulverizing plants. As these plants demonstrate their efficiency, there should be an increased demand for such mills. These mills require specially hardened castings, which are not available in France at present. The demand for such castings extends to mills for other purposes—mills whose other parts are made and assembled by local manufacturers.

Railway Prospects in Persia.

Last January the Persian Government gave to the Persian Railway Syndicate an option for the construction and equipment of a railway from Khanikin to Teheran via Kermanshah and Hamadan, with a branch to Enzeli on the Caspian Sea. The Persian Government has reserved the right to decide later whether the railway is to be constructed as a Persian State line or whether a concession shall be granted to the syndicate to build the line with a Persian Government guaranty on such terms as may be necessary and practicable. If the railway is built as a Persian State line, the capital necessary for the undertaking would be raised by the issue of Persian Government bonds secured by the necessary guarantees.

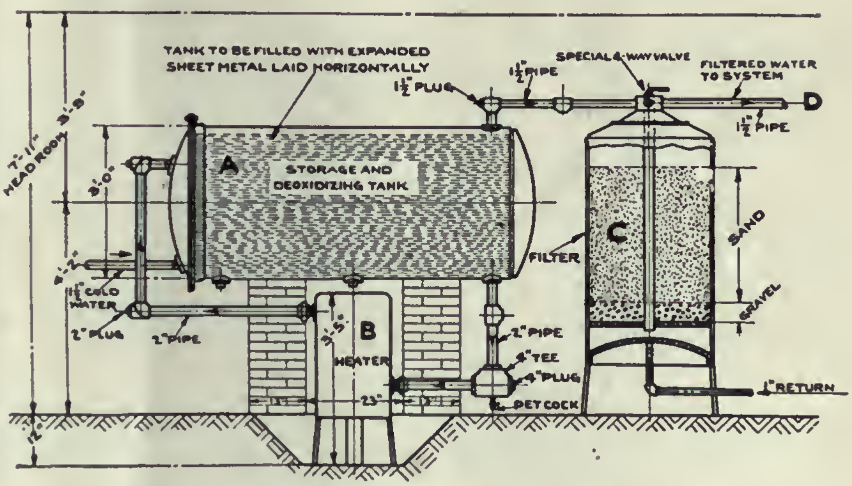
Preventing Corrosion in Water Pipes.

It is to the Research Laboratory of Applied Chemistry of the Massachusetts Institute of Technology that we owe what may properly be called the discovery of the function of oxygen in the corrosion of iron. In other words the cause of the rusting of iron was explained for the first time. This was in 1907. As is well known rusting takes place at ordinary temperatures only in the presence of water. A metallic iron atom, electrically neutral, interacts with two hydrogen ions present in the water. An ion, it may be stated, consists of one or more atoms and carries a small charge of electricity. The result is the production of an iron ion which takes up two electrical charges from the hydrogen ions and the deposition of two atoms of hydrogen. Energy is lost to the surroundings and appears as heat.

Among the factors which influence the action, the first is the solution pressure of the iron. This is constant under all samples of iron under constant conditions, but may be influenced by a number of agents. Thus the immunity of iron to corrosion in solutions of chromic acid is caused by the passivity, or the quality of being easily acted upon, of the iron,—a thing which, whatever its true nature, is equivalent to lowering the electrolytic solution-pressure of the metal. It will be readily understood that if any substance forming hydrogen ions, such as carbonic acid or bicarbonate of sulphur dioxide or any acid-forming compound, be present, corrosion is accelerated. On the other hand, if an alkaline material such as soda ash or caustic soda be present, the number of hydrogen ions is decreased and corrosion is retarded. If enough of the active ion of an alkaline compound be present, practically all of the hydrogen will disappear and corrosion will entirely cease.

Both laboratory and large-scale experimentation demonstrate that the rate of corrosion is directly proportional to the amount of oxygen, or air, dissolved in the water. If no air is present there will be no corrosion. These important facts have been made the basis of improvements in engineering practice, and the dangers and losses due to the corrosion of iron are constantly being decreased. Among other improvements developed in recent advances in anti-corrosion engineering are a process for eliminating the mill scale from the inside of steel pipe, and a process for removing the dissolved oxygen from feed water from boilers or other hot-water supply systems. The first depends upon the fact that there exists a temperature where steel is plastic and easily deformed, but where, at the same temperature, mill scale is brittle and non-elastic. If now a welded pipe is cooled to this temperature, and held there while it is subjected to mechanical working, the pipe is not permanently deformed, but the scale loses its adherence and falls off. Deprived of this the pipe will suffer but slightly over its entire surface from corrosion. In the case of feed water, if ferrous hydroxide be introduced into the water from without, it will quickly unite with the dissolved oxygen and in this way permit the separated hydrogen to protect the iron continuously from further solution.

Devices have been already successfully operated to effect the conditions referred to, and a typical installation is shown in



THE PROPOSED SYSTEM FOR PREVENTING CORROSION OF WATER PIPES

the attached figure. It consists of a tank A, in which is placed a large number of perforated sheets of iron, over and through which the incoming water must pass. The water is heated by circulating through the heater B, as shown by the arrows. During its passage through this tank, the oxygen of the water is consumed, producing an equivalent quantity of red iron hydroxide, a portion of which remains in the tank while a portion passes with the water to the sand filter C. From thence all of the floating rust is removed and a clear, pure deactivated water is supplied for the purpose desired through the exit pipe D. The removal of the dissolved oxygen from the water thus effected after nearly a year's operation has been found to be almost mathematically complete. The process recommends itself as a practical means of overcoming a serious difficulty in the maintenance of a water supply free from corrosive influences.

Snap Shots—By the Wanderer

I was tinkering on some private matters the other day, when a friend expressed 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. I happened to know that Snide & Co. haven't a decent tool in their establishment and also that the tools which they sell have a very nice external appearance and they do business on that, and their price. I can never quite get accustomed to this bargain counter craze on the part of amateur mechanics who want tools for their own work. Because of all the dear things in the catalogue of those on earth the cheap tool is the dearest. In marked contrast to this is the attitude of the first-class mechanic who wants and buys the best that there is made and finds it none too good. But as with the purchasing agent, who has had no experience with the working of the things that he buys, price is apt to be the controlling factor with the ignorant.

Trouble is frequently experienced with the cracking of fire-box sheets about the tubes that are expanded through the water leg for the placement of the steam jets that are used for inducing air currents above the fire and the prevention of smoke. This cracking is undoubtedly caused by the local cooling of the sheets about the hole, resulting in a contraction and setting up of tension stresses in the metal, that exceed its strength. The probability is that the sensitiveness of boiler plates to currents of cool air is much greater than most engineers realize and that these small streams of air entering under the influence of the draft cause more trouble than they appreciate. It seems probable that the inflow of air at these points is much less detrimental when the steam jets are in operation than when they are shut off. Under the latter conditions, the air enters comparatively slowly and is swept along over the surface of the sheets taking heat from them and cooling them appreciably. Whereas, when the steam jets are in operation, the air enters with such velocity that it is probably carried away from the plates and into the body of the fire where its oxygen enters into the combustion of the fuel and the sheets are not cooled except at the very edge of the hole as the air moves past. For this reason it would seem to be advisable to keep the jets in action at all times when the engine is at work, and possibly even when the steam is shut off from the cylinders. These are matters that have not yet been definitely worked out, but seem to be reasonable.

Is he really guilty or not, that man who ran by a signal set against him or took a curve at an excessive speed? The Supreme Court of the United States has handed down a decision that he is guilty of wilful and wanton negligence. The law holds a man responsible and considers that he knows what may be the consequence of his acts. That is all right, but, for the sake of argument, may it not happen that a perfectly sane man may be in such a mental condition as to be unconscious of his acts? I was discussing the matter with a prominent superintendent of motive power not long since, and he said that the first steps which he took in the investigation of a run-past-a-signal or similar accident was to look into the probable mental condition of the man. Had he had domestic or financial troubles to worry or distract him? Had there been a death or illness in his family? If these conditions were known to have existed he felt that he had at least made an approach to the cause of the neglect.

If the man was temporarily rendered mentally incompetent, that is, deranged, ought he to be held legally responsible? Here is a case in point. There was a bad disaster, four score and more of passengers killed. It was a case of attempting to negotiate a curve at too high a speed. The head of the train took it all right, but the center of the train left the rails, with the result stated. The driver escaped unhurt. He was tried for manslaughter and acquitted on the grounds of a failure of the air brakes. No one really knew whether the air brakes failed or not, and the jury did not know that a few days before the wreck the man had lost and buried a young child and at the time his wife was seriously ill. The probability is that the man was driven almost to distraction by his troubles and that his work was the last thing in the world he was thinking about. It is also probable if not certain that the man was totally unconscious of the fact that his mental condition quite incapacitated him for the proper performance of the responsible duties put upon him. He was conscientious, and knowing that the company, in a shortage of men, needed his services, he went to work. There is the case: a competent man rendered incompetent by anxiety and grief, yet quite unconscious of his own temporary incompetency. If you had been on a jury trying this man for manslaughter and the facts, as here stated, had been offered to you, would you have found him guilty or not guilty of criminal negligence?

Now, whether that man was guilty or not guilty, what are you going to do with the man higher up? In these days of the coddling of the supposedly downtrodden, the first instinct of some of the people and the yellow press is to shield the man who actually made the mistake and seize upon his superior officer as the guilty party. He is either accused of hiring an incompetent man; for not providing him with suitable implements for the proper performance of his work; for neglect to issue suitable instructions and for dereliction in any other direction which the prosecuting attorney can think of. Where good and competent men with years of clean record go wrong, it is head trouble that is usually the cause. The point taken here is whether the division or general superintendent or any general officer should be required to regularly inquire into the daily habit or domestic condition of each man before sending him out on the road in charge of a train. And, if it is not done regularly and systematically, it is certainly useless to do it at all, for the accident would be sure to occur on the day of omission and the last state of that officer would be worse than the first. But the majesty of the law must be sustained and to make a morning quarrel with his wife a legal excuse for an engineer running past a signal and killing a dozen people would be going far and fast. But the question arises as to whether when a witness is put upon the stand and made to swear that he will tell the truth, the whole truth and nothing but the truth, it would be well to let him do so and not place so many impediments in his way.

Possibly, if the advocates of speed control and automatic stops are right, all this will be avoided when these infallible remedies have been applied. Then all the driver will have to do will be to start and let her go, and the simple apparatus will work out his salvation and make his engine and train do all that it ought to do. He will simply have to sit by and look at the scenery, and there will be smooth and even running with stops at times of danger. The responsibility will be taken from the man and if there is any trial the verdict of guilty or not guilty will have to be rendered against a piece of apparatus that can know no pangs of conscience.

Details of Parts of the Pacific Type Locomotive as Shown in Our Chart, No. 12

Smokebox, Superheater and Throttle Valve.

The illustrated portion of the Pacific locomotive chart presented herewith includes the smokebox, superheater, throttle valve and steampipe connections. The smokebox, for the engine under consideration, has an outside diameter of 6 ft. 10 in. and a length of 6 ft. 3½ in. from the front tubeshead to the outside of the front smokebox ring. The throttle is set back in the dome, not shown in the illustration, and is connected with the superheater head by a dry pipe (1) which is 8½ in. inside diameter. The throttle used is the Chambers and is of the balanced type. It is operated by a throttle rod attached to the crank arm (2) which is keyed to the shaft (3). This shaft carries a lifting arm (4) at each end to which are attached side bars (5). These, in turn, are coupled to a cross bar (6) to which the stem of the balancing drifting valve (7) is attached. As the upper end of the crank arm is moved to the left, the side bars are raised and, with them, the drifting valve, which is of small area so that it is easily raised against the pressure of the steam on its back. This valve has a lift of only about ⅛ in. and admits steam to the balancing chamber (10). The valve itself consists of a main valve disc (11) and a balancing piston (12) which moves in the balancing chamber and is packed with the ordinary ring packing (13). The valve rests upon an inserted bronze seat (14), which is put into the upper opening of the casing (15) in the form of a bushing. The casing is in the form of an elbow having a double wall at the top. The inner wall forms the balancing chamber, and has openings through the upper portion for the passage of steam. The annular space between the two walls (16) forms a passage from the top to the lower portion. The main valve is opened by a shoulder on the balancing and drifting valvestem, striking against a boss on the underside of the balancing piston, when the balancing and drifting valve has been raised about ⅛ in., and any further movement of the stem carries the main valve with it.

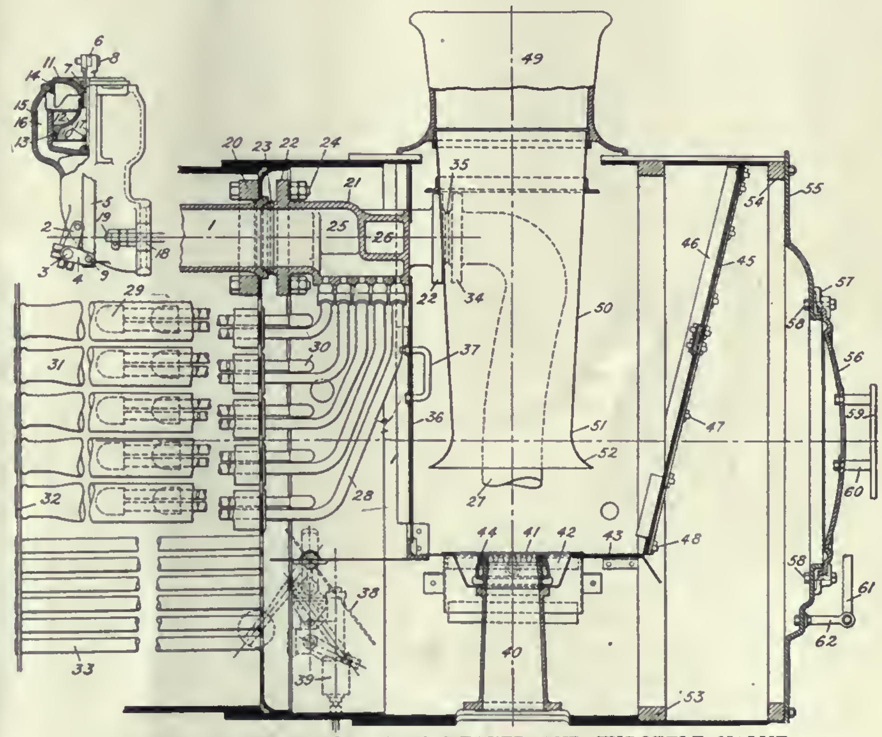
The throttle casing is fastened to the dry pipe by means of two ears (18), through which the 1¼ in. bolts (19) pass. These bolts pass through similar ears on a ring attached to the dry pipe, and serve to draw the dry pipe and casing together. The steam tight joint between the two is made by a ring on the dry pipe fitting into a ground seat in the throttle casing, and which lies at an angle of 45° with the center line.

The hole in the front tubesheet, through which the dry pipe passes into the smokebox is stiffened by the drypipe stiffening ring (20). The connection between the dry pipe and the superheater header (21) is made by means of a ball joint and ring (23) which is placed between the two. This ball joint and ring has a spherical contour on the surface of contact between it and the end of the dry pipe and a flat surface for the contact with the header; both of which are ground to make a steam tight joint. The whole is held together by the bolts (24) passing through the dry pipe stiffening ring and the superheater header flange (22).

The superheater header is formed by two chambers. The first one (25) is called the saturated steam passage and the second (26) is the superheated steam passage. The saturated steam passage receives the steam direct from the dry pipe and the boiler, and the superheated steam passage delivers the superheated steam to the steam pipes (27) leading to the cylinders. The connection between these two passages is made by means of the superheater units (28). Each of these units is formed by four lengths of pipe and three forged return bends. These are two tube return bends (29) and one smokebox return bend (30). A single pipe is attached by a special fastening, not shown in detail in the engraving, to the saturated steam passage of the superheater header. This leads back to one of the tube return bends, thence to the smoke box return bend, again back to the second tube return bend, and finally out to a connection with the superheated steam passage of the header. The saturated steam thus passes the length of the portion of the unit in the tube four times before it is discharged as superheated steam into the superheated passage.

The tubes (31), in which the units are placed are 5½ in. in diameter of which there are 40 in the boiler under consideration. These are swaged down to a smaller diameter at the back end and fastened to the back tubesheet by expanding and beading (32). The ordinary boiler tube (33) is 2¼ in. in diameter and there are 236 in this boiler. They are expanded and headed into the back tubesheet in the same manner as the superheater tubes. The connection between the superheater header and the steam pipe is made in the same way as between the dry-pipe and the superheater header. There is a flange on the header (22) with a corresponding one (34) on the steam-pipe, while between is a steam-pipe ball joint ring (35) fitted in exactly the same way as the dry pipe ball joint ring, and with the spherical joint in the superheater header.

In front of the superheater tubes and units there is a diaphragm (36) which is provided with handles (37) for removing it when necessary. At the bottom there



DETAILS OF SMOKEBOX, SUPERHEATER AND THROTTLE VALVE is a superheater damper (38) and a cylinder (39) for operating it. This mechanism works automatically, opening the damper when steam is being used in the cylinders, and closing it when the steam is shut off and the engine standing or drifting, thus protecting the superheater units from overheating when there is no steam in them.

In the bottom of smoke box there is the exhaust pipe (40), to the top of which is fastened a muffled exhaust nozzle (41). This nozzle sets down in a pocket (42) in the floor plate (43) of the diaphragm. The peculiarity of this exhaust nozzle is that the main opening is surrounded by a crown of small jets (44) to which steam is delivered from an annular passage below.

From the front edge of the floor of the diaphragm the netting (45) rises to the front and top of the smoke box. This netting is held by a frame (46), and is provided with a door (47), held by bolts (48) with split keys, through which access is gained to the interior of the smoke box.

The stack (49) is of cast iron with an inside diameter of 22 in. at the bottom and a height of 21 in. above the smoke box. The inside diameter at the top is 24 in. and the inner walls are a continuation of those of the inside stack or lift pipe (50). This lift pipe has a choke diameter (51) of 17 in. with a flare (52) below it out to a diameter of 24 in. The choke is placed 17½ in. above the top of the exhaust nozzle.

The smoke box is stiffened by a 4 in. by 2 in. intermediate ring (53) and a front ring (54) to which the boiler front (55) is bolted. The boiler front is of cast iron and about ⅝ in. thick. At the center it has an opening which is closed by a door (56). This door swings on hinges on the left hand side, which are not shown in the engraving, and is held shut by the clamps (57) which, in turn, are tightened by the bolts (58).

The boiler front door carries at its center the number plate (59) which is held in place by studs (60). There is also a hand rail (61) held by a post or bracket (62).

The following is a list of the reference figures on this portion of the locomotive:

LIST OF PARTS

1 Dry pipe.
2 Throttle crank arm.
3 Throttle crank arm shaft.
4 Throttle lifting arm.
5 Throttle side bar.
6 Throttle cross bar.
7 Throttle balancing drifting valve.
8 Throttle cross bar and drifting valve pin.
9 Throttle lifting arm and side bar pin.
10 Throttle balancing chamber.
11 Throttle valve disc.
12 Throttle balancing piston.
13 Throttle balancing piston packing.
14 Throttle valve seat.
15 Throttle casing.
16 Throttle steam passage.
17 Throttle balancing and drifting valve stem.
18 Throttle casing ear.
19 Throttle casing and dry pipe bolt.
20 Dry pipe stiffening ring.
21 Superheater header.
22 Superheater header flange.
23 Dry pipe ball joint ring.
24 Dry pipe and superheater header bolt.
25 Saturated steam passage of header.
26 Superheated steam passage of header.
27 Steam pipe.
28 Superheater unit.
29 Tube return bend for superheater unit.
30 Smokebox return bend for superheater unit.
31 Superheater tube.
32 Tube heading.
33 Boiler tube.
34 Steam pipe flange.
35 Steam pipe ball joint ring.
36 Diaphragm.
37 Diaphragm handle.
38 Superheater damper.
39 Superheater damper cylinder.
40 Exhaust pipe.
41 Muffled exhaust nozzle.
42 Diaphragm pocket.
43 Diaphragm floor plate.
44 Exhaust nozzle muffler jet.
45 Smokebox netting.
46 Smokebox netting frame.
47 Smokebox netting door.
48 Smokebox netting door bolts.
49 Smokestack.
50 Inside stack or lift pipe.
51 Choke of lift pipe.
52 Lift pipe flare.
53 Intermediate smokebox ring.
54 Front smokebox ring.
55 Boiler front.
56 Smokebox door.
57 Smokebox door clamp.
58 Smokebox door clamp bolt.
59 Number plate.
60 Number plate stud.
61 Boiler front hand rail.
62 Boiler front hand rail bracket.

Southern Valve Gear Company.

The Southern Locomotive Valve Gear Company, whose manufacturing activities had been largely diverted to other channels during the war period, has been reorganized, and the properties of the original company purchased, and with extended facilities, the new company is in a position to meet the growing demands for Southern valve gears and Brown power reverse gears, which are already extensively in operation in some of the leading American railroads, and also in several foreign countries, a large number of locomotives in Australia being recently equipped with this type of valve gear. General L. D. Tyson, president of the former company, has been elected president of the new organization, which will be known as the Southern Valve Gear Company. Forrest W. Andrews has been elected vice-president; William Whaley, general manager, and H. P. Strayer, secretary. The headquarters of the company are located at Knoxville, Tenn.

Locomotives Exported to Foreign Countries

It is gratifying to observe that the demand for locomotives in the South American republics shows an increase as will be observed from the monthly reports of the last year, the domestic reports from the United States by countries, during the month of February, 1920, being as follows:

Steam Locomotives.

Countries	*Number*	*Dollars*
Italy	30	1,114,000
Spain	1	20,125
Canada	6	51,107
Salvador	1	23,325
Mexico	4	41,376
Jamaica	1	12,500
Other British W. Indies	1	5,785
Cuba	12	314,815
Dominican Republic	1	7,800
Argentina	3	21,000
Brazil	6	136,505
Chile	1	3,835
China	4	81,537
Japanese China	8	350,680
British India	1	9,650
Dutch East Indies......	6	299,040
Japan	2	12,144
British South Africa....	3	179,250
Poland and Danzig.....	41	1,903,600
Total	132	4,588,074

Asbestos Gasket.

A cheap method of making a tight flange joint, and one that will stay tight, is to use wet sheet asbestos 1/16-inch thick. This can be used only when the flange is lying flat and the other half can be carefully lowered upon it, as wet sheet asbestos becomes so soft that it cannot be handled. The gasket must be cut to the proper size, then laid on the face of the flange and water applied. Joints made in this way fifteen years ago are still tight.

Tempering Oils.

The essential requirements of tempering oils are: flash and fire tests high enough to avoid serious evaporation loss or to incur high fire risk, comparative freedom from decomposition, absence of acid or acid-forming substances which would have a materially corrosive action on metals at high temperature, a fairly high heat capacity, and enough fluidity to permit rapid carrying-away of the heat.

Electrical Department

Safety First Fuse Box—Classification of Electric Locomotives

A Safety-First Fuse Box.

In the distribution of electric power for industrial purposes, the transformer is universally used. The electricity leaves the power house at a high voltage, since high voltage means greater efficiency of transmission, and is carried at that voltage to the vicinity of the power load. A distributing transformer, suitable for outdoor service is used to step the voltage down to that used at the motors. These transformers must be protected by a fuse and the following description covers an ideal fuse box for the protection of the outdoor transformer. It is a box that can be depended upon to operate on an overload, it is one that is easily re-fused and quickly put back into service and what is the most important, it is safe.

A distributing transformer requires occasional inspection and a fuse when blown requires replacement so that when the fuse box is spoken of as safe, we mean that it is not partially safe against accidental contact by the attendant but one hundred per cent safe under all possible conditions except the actual intent to touch a live part. In this OD safety fuse box, manufactured by the Westinghouse Co., the complete separation of those parts to be handled from all live parts is accomplished automatically by opening the door.

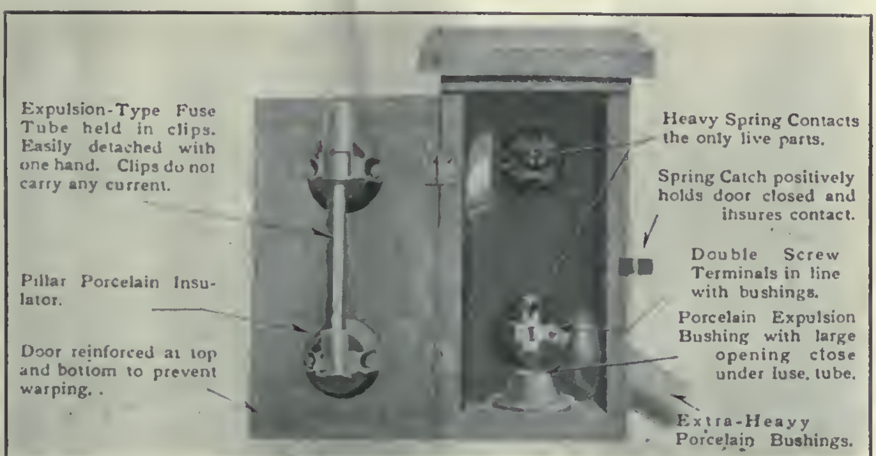
The fuse box is complete in itself. No tools are required. The box is supported by a strap hanger which is screwed to the cross arm.

The operation is as follows: The fuse is of the expulsion principle. It consists of a tube open at the bottom but closed at the top and forming a closed chamber known as the expulsion chamber. The fuse is placed in the tube. We all know that when a fuse opens there is formed a large amount of gas due to the burning of the metal. In the case of the expulsion fuse the gases collect in the chamber and then blow out suddenly through the bottom of the fuse. The fuse is carried with it, as well as the electric arc and the circuit is opened. The gases blown out of the bottom of the tube pass through a porcelain bushing in the bottom of the box, the bushing being located close to and directly beneath the open end of the tube.

When a fuse is blown the gases expelled from the fuse tube puncture a piece of paper clamped under the box. The puncture can be seen from the ground by day or night—the use of a pocket electric flash light makes such inspection easy at night—and is a sure indication of the condition of the fuse.

To put in a new fuse or re-fuse as it is called, no hook stick, tongs, or other tools are necessary, except a screwdriver for clamping the fuse in the tube. When the door of the box is opened, the fuse tube, the part to be handled, is disconnected from the line and can therefore be safely and easily disengaged from its clips by one hand. The fuse tube is re-fused and, with one hand, is inserted in place and the door closed; the fuse box is again in operation.

The fuse tube is held in fuse clips mounted on 7,500-volt insulators on the door of the box. The clips carry no current but merely hold the tube in place. Heavy spring fingers are mounted on 7,500-volt insulators on the rear of the box in such a way that contact is made between the fingers and brass ferrules on the fuse tube when the door of the box is closed and, as already stated, is in operation.



THE SAFETY FIRST FUSE BOX

Classification of the Electric Locomotive.

The electrical design of the locomotive will depend on the system of electrification with which it is to be used. The electrical systems may be classified under two headings as follows:

(1) Direct Current Systems.

(2) Alternating Current Systems.

The Direct Current Systems may be at either high or low voltage, varying from 600-700 volts up to 3,000 volts. The Alternating Current Systems may be either Single Phase or Three Phase with voltages from 3,300 volts up to 11,000 volts or even higher.

The collection of the electric power for operating the locomotive is one of the important and interesting points. Electricity for transportation was first used on the street railways. An overhead trolley, carrying 500 volts direct current was used. As greater loads were demanded, due to the operation of more and larger cars, it was necessary to provide greater capacity in the trolley wire for carrying the required current. The capacity of the wire was limited so that copper feeders were installed in parallel with the wire. When steam railroads operating heavy train service were electrified using direct current at 600-700 volts, a power greater than could ever be delivered by the wire was required, so that the third rail contact system was used to provide the necessary current carrying capacity.

In a typical third rail contact system, the power is generated at a central power house and transmitted out to the substations as high voltage three phase alternating current. At the substations this three phase power is reduced by transformers and then converted by rotary converters into direct current. This direct current is distributed from the substation to the third rail by feeders. Ordinarily the track rails are used for the return current, but in the case of heavy systems, copper cables, known as negative feeders, are connected in parallel with the rails so as to reduce the voltage drop back to the substation.

There were limitations to the third rail system. While in very dry climates 1,200 volts can be used on the third rail, it may be said in general that this system of electrification is one of 700 volts. The comparatively low voltage, where heavy train service exists requiring considerable horsepower, means an abundance of copper, substations, etc, to care for the heavy current necessary for the operation of the numerous heavy trains over long distances. Naturally to eliminate the excessive copper and substations a higher voltage was required. Subsequently, the overhead contact system, using high voltage single phase or three phase alternating current was employed and recently high voltage direct current has been used on the overhead system with success. In typical single phase systems, the power is transmitted at high voltage to the transformer substations, where it is transformed down to the workable voltage and connected directly to the overhead contact system as single phase current.

In the case of the three phase system, three phase power instead of single phase is delivered to the locomotives. This requires that two contact wires insulated from each other be placed above the tracks, the rails forming the third wire.

The high voltage direct current overhead system is similar to the low voltage direct current third rail system. The power is transmitted in the same way, converted by rotating machinery, but is fed at high voltage to an overhead conductor instead of to a third rail.

Besides the internal apparatus of the electric locomotive being designed according to the system over which it will operate, there is another fundamental point of difference which lies in the method employed in the collection of the current. From this point of view, the locomotives can be classified under two headings—

(1) Those equipped with pantagraph trolleys to collect the current at high voltages from overhead wires located several feet above and directly over the track.

(2) Those equipped with third rail shoes to collect the current from conductors located alongside of and adjacent to the running rails.

With either type of construction the conductor must be insulated to prevent leakage of the electric current, and so located that there will be the minimum interference with existing structures. There must also be no interference with the rolling equipment and that it will permit of safe and satisfactory operation of the electric locomotives.

Cutting Power of Lathe Tools.

The British Institute of Mechanical Engineers at a recent meeting discussed lathe tools, in the course of which G. W. Burley, an eminent authority on the subject stated that there is no practical cutting speed below which it is impossible to obtain a satisfactory surface on plain carbon steels by means of ordinary lathe finishing tools, whether these be made of plain carbon tools steel, ordinary (non-vanadium) high-speed steel, or superior (vanadium) high-speed steel. There is, however, a maximum limiting speed at above which a satisfactory finish cannot be obtained on account of the tendency of the tool to pluck at and tear the surface, this tendency being related to the phenomenon of building up on the cutting edge of the tool. For the finishing of mild steel this limit is not very different for each of the above three varieties of tool steel and is within the range of 48 feet to 58 feet per minute. For the finishing of hard steel this limit does depend somewhat on the variety of tool steel which is employed and is within the ranges of 23 feet to 28 feet, 17 feet to 21 feet, and 28 feet to 34 feet per minute for the three varieties of tool steel respectively.

(2) The durability or life of a lathe finishing tool, whether of plain carbon or high-speed steel, is for all cutting speeds below the limiting speed some function of the reciprocal of the cutting speed; in other words, an increase in the cutting speed below the limiting value is always accompanied by a decrease in the life or durability of the tool.

(3) The most suitable angle of side rake (that is, the angle of side rake associated with maximum durability and cutting power) for a high-speed lathe roughing tool working on steel depends upon the physical properties of the steel. For mild steel turning it lies between 20 deg. and 25 deg, whilst for hard steel turning it is of the order of 10 deg., and if these angles are either increased or reduced there is always a depreciation of cutting power.

(4) The color of the turnings formed by a high-speed lathe roughing tool when working on steel is not necessarily a true index of the condition of maximum cutting efficiency. Thus in the case of hard steel turning the turning color which is associated with maximum cutting efficiency is a pale blue, whilst a mild steel turning which is removed under the conditions of maximum efficiency is practically uncolored, apart, of course, from the natural grey color of the steel.

(5) The net power consumption of a high-speed roughing tool is dependent, other conditions being constant, upon the amount of top rake on the tool, the relation between these two quantities being reciprocal in character, so that, within the limits of ordinary practice, a reduction in the top rake angles of a tool is always accompanied by an increase in the net amount of power consumed. The law connecting the variations of the two quantities appears to be of the nature of a straight line law for all qualities of steel machined. There are therefore no critical values of the rake angles in regard to power consumption as there are in regard to durability and cutting power.

Students at Real Work.

The strike among the railway men in Great Britain last September brought out a large number of what are usually called gentlemen of leisure whose services were eagerly accepted by the railway managers, and no doubt the kid-gloved aristocrats had some effect in hastening the settlement of the strike that threatened to paralyze the transportation system of the United Kingdom. Probably in emulation of this example all sorts and conditions of men took to railroad work in the recent strike among certain classes of railway men in America. Quite a number of college students showed an eagerness to try their hand at railroading, and, apart from the merits or demerits of the controversy, it cannot be other than beneficial to the students to realize what a real day's work is. Of course, the lesson would have been more impressive if the experiment had occurred in the dog days with the thermometer about 100 deg. F., and the foot plates with their sizzling augmentation of heat superinduced by the burning of five or six tons of coal per hour.

Photo by International Film Service

UNIVERSITY OF PENNSYLVANIA STUDENTS IN RAILWAY YARDS

Items of Personal Interest

L. V. Gould has been appointed purchasing agent of the Union Pacific, succeeding G. H. Robinson, transferred.

E. P. Poole has been appointed supervisor of shops of the Baltimore & Ohio, with headquarters at Baltimore, Md.

J. F. Griffin has been appointed chief draftsman of the Locomotive Feed Water Heater Company, 30 Church Street, New York.

F. P. Barnes has been appointed master mechanic of the Colorado, Wyoming & Eastern, succeeding A. D. Howard, resigned.

Alonzo Ross has been appointed superintendent of stores of the New York region of the Erie, with headquarters at Jersey City, N. J.

George H. Snyder, chief clerk of the American Steel Foundries, has been appointed sales engineer of the company, with headquarters at St. Paul, Minn.

John J. Mulreney has been appointed master mechanic of the Detroit & Mackinac, with headquarters at East Towers, Mich., succeeding H. T. Thomas, retired.

Charles Hyland has been appointed mechanical superintendent of the Toledo Terminal, with headquarters at the Boulevard Shops of the Toledo Terminal at Toledo, Ohio.

Alfred E. Calkins, engineer of rolling stock of the New York Central, has been appointed superintendent of rolling stock, lines east of Buffalo, with headquarters at New York.

N. M. Barker, master mechanic of the Copper Range railroad, has been appointed mechanical superintendent of the American Automatic Connector Company, Cleveland, Ohio.

G. S. Edmonds, shop superintendent of the Delaware & Hudson at Colonie, N. Y., has been appointed acting superintendent of motive power, succeeding J. H. Manning, deceased.

R. H. Dwyer, trainmaster on the Missouri Pacific, at Alexandria, La., has been appointed superintendent of safety, with headquarters at St. Louis, Mo., succeeding M. McKernan, assigned to other duties.

J. E. Goodman has resumed the duties of master mechanic of the Lake Superior division of the Northern Pacific, with headquarters at Duluth, Minn., succeeding J. A. Marshall, assigned to other duties.

A. J. Devlin, master mechanic of the Western division of the St. Louis, Francisco, at Enid, Okla., has been appointed shop superintendent of the north shops at Springfield, Mo., succeeding J. F. Henshaw, transferred.

E. Eugene Adams, consulting engineer of the Union Pacific, with headquarters at New York, has been appointed assistant to the president in charge of purchases, engineering and standards, with headquarters at Omaha, Neb.

F. W. Rhuark, formerly master mechanic of the Baltimore & Ohio, with headquarters at Connellsville, Pa., has been appointed mechanical superintendent of the Pittsburgh & West Virginia, with headquarters at Pittsburgh, Pa.

F. R. Bolles, formerly with the Chicago, Milwaukee & St. Paul, and recently vice-president and general manager of the Copper Range railroad, has been elected vice-president and general manager of the Railway Automatic Connection Company of Cleveland, Ohio.

Photo by International Film Service
W. N. DOAK AND SENATOR CUMMINS

J. J. Byrne has been appointed district representative of the Locomotive Stoker Company, with offices at Washington, D. C. Mr. Byrne has had a wide experience in the mechanical department of railways, and has been active in the development of the locomotive stoker.

E. Bowie has been appointed master mechanic of the Brownville division of the Canadian Pacific, with office at Brownville Junction, Me., succeeding W. Wright, transferred, and A. Edwards has been appointed locomotive foreman at McAdam, succeeding R. A. Miller, transferred.

James Reed, assistant car builder on the New York Central, has been appointed master car builder with headquarters at Englewood, N. Y. George Thomson, formerly at Englewood, has been transferred to Cleveland, Ohio, and A. Webster has been promoted to the position of assistant car builder.

W. G. Strachan, road foreman of engineers on the Canadian National Railways, Superior division, has been appointed master mechanic with offices at Hornepayne, Ont. J. Hawkins, road foreman of engineers, has been appointed assistant master mechanic on the Ottawa division with offices at Ottawa.

W. R. Parker, road foreman of engines of the Southern Pacific at Stockton, Cal., has been transferred to West Oakland, Cal., succeeding E. E. House, retired, and G. B. Jeffers has been appointed road foreman of engines of the Stockton division with headquarters at Tracy, Cal., succeeding W. R. Parker.

J. E. Goodman, after a leave of absence extending over several months, has resumed his duties as master mechanic of the Lake Superior division of the Northern Pacific, with offices at Duluth, Minn., and John A. Marshall, acting master mechanic, has resumed his position as road foreman of engines at Duluth.

H. U. Morton, vice-president of the Dunbar Manufacturing Company, Chicago, has been elected president of that company, succeeding Thomas Dunbar, resigned. During the war the company was engaged in the production of artillery ammunition bodies, but has now resumed the manufacture and sale of railway car appliances.

Frank P. Roesch, general supervisor of fuel conservation under the United States Railroad Administration, and formerly master mechanic of the El Paso & Southwestern, the Southern Railway, and the Chicago & Alton, has been appointed western manager of the Standard Stoker Company, with offices at 1549 McCormick building, Chicago, Ill.

A. C. Deverell, general superintendent of motive power of the Great Northern, has resigned to become Western sales manager of the Locomotive Stoker Company, with offices in Chicago, Ill. Mr. Deverell's excellent record as a leading official in locomotive construction and repair is an assurance of another valuable addition to the staff of the Locomotive Stoker Company.

W. N. Doak, vice-president of the Brotherhood of Railroad Trainmen, and Albert B. Cummins, United States Senator from Iowa, among others, have been particularly active in their efforts to settle the disturbances among the striking railroad men. Mr. Doak has insisted on recognizing the authority of the regularly elected executives of the various Brotherhoods, while Senator Cummins advocated the prompt appointment of the Arbitration Board.

Frederick W. Brazier, formerly superintendent of rolling stock of the New York Central, and who has been over forty years in active railroad service on various railroads as carpenter, foreman, general foreman, superintendent, and assistant superintendent of machinery, and who had proposed retiring from active service, has consented to continue his service on the New York Central, by assuming the position of assistant to the General Superintendent of rolling stock, and W. O. Thompson, whose appointment to the chief position was recently noted, will have the benefit of the counsel and experience of Mr. Brazier.

H. C. Woodbridge has been appointed representative of the Locomotive Stoker Company at Pittsburgh, Pa. Mr. Woodbridge was supervisor of the fuel conservation section of the United States Railroad Administration. In 1897 he graduated as mechanical engineer from Cornell University, and was for some time engaged as traveling engineer and inspector for the American Locomotive Company, and at a later date master mechanic of the Buffalo, Rochester & Pittsburgh. In 1909 he was appointed assistant to the general manager, for which position he was called to the service of the Federal Government, as above noted.

W. H. Patterson, manager, resale section, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been appointed assistant-to-manager, industrial department, in charge of metal making and wood making industries. Mr. Patterson is a graduate of Purdue University, and entered the apprenticeship course of the Westinghouse Company in 1900. In 1910 he was appointed manager of the resale section. During the war he served on the United States Shipping Board Emergency Fleet Corporation, Electric Welding Committee. In the organization of the American Welding Society Mr. Patterson was elected a director. He is also an active member of the leading electric societies and the American Society of Refrigeration Engineers.

OBITUARY

James H. Manning.

James H. Manning, superintendent of motive power of the Delaware & Hudson, died on April 15, in the fifty-ninth year of his age. Mr. Manning entered railroad service as a machinist's apprentice on the Union Pacific in 1876. From 1883 to 1886 he was gang foreman and from the latter date until 1890 general foreman. From 1890 to 1898, master mechanic at Omaha, Neb., and latterly transferred to Cheyenne, Wyo. He was several years in the foundry business, and in 1903 was appointed superintendent of rolling stock of the Canadian Pacific. In 1904 he was superintendent of motive power of the Delaware & Hudson, which position he held at the time of his death.

Thomas J. Burns.

Thomas J. Burns, superintendent rolling stock of the Michigan Central Railroad, died at Detroit on April 18. Mr. Burns was born at Hillsdale, Mich., July 24, 1868; was a graduate of Assumption College, Sandwich, and spent several years at Grand Seminary, Montreal. He entered railroad service April 4, 1890, as clerk in the maintenance of Way Department of the Michigan Central at Bay City, Mich. He was promoted to engine despatcher on Nov. 1, 1896, and was appointed chief clerk to master mechanic at Jackson on Dec. 15, 1902. In August, 1905, he was transferred to Detroit as chief clerk to superintendent motive power, was promoted to assistant to superintendent motive power on July 1, 1909, and to assistant superintendent motive power on June 1, 1912. On May 1, 1915, the locomotive and car departments were separated, he being appointed superintendent rolling stock at that time, holding this position at the time of his death.

Frederick O. Robinson.

Frederick Ovil Robinson, for many years chief clerk to the superintendent of motive power of the Chesapeake & Ohio Railroad and secretary of the Richmond Railroad Club, died at Richmond, Va., on March 28. Mr. Robinson was born in Farmington, N. M., August 20, 1852, and entered railway service as a telegraph operator on the Indianapolis, Peru and Chicago Railroad, and in a short time was appointed chief clerk to the master mechanic. Possessed of considerable literary ability he had many offers as chief clerk, and in 1892 entered the service of the Chesapeake & Ohio as chief clerk of the purchasing department, and in 1895 was appointed chief motive power clerk, and in 1911 was appointed equipment clerk of the same road, which position he filled until very recently. He was elected secretary-treasurer of the Richmond Railroad Club on its organization, which office he filled until his death. He was widely known and highly esteemed among railroad mechanical officials and railroad employees generally.

Railway Electrical Engineers.

The Association of Railway Electrical Engineers will hold the semi-annual meeting at Atlantic City, N. J., on June 14. Reports will be presented by special committees on electric welding, trucks and tractors, train lighting equipment and practice, railway stationary power plants, electric headlights, and electric facilities and equipment. The association is steadily growing in membership and activity.

Railway Executives' Meeting

A meeting of the Association of Railway Executives was held in Chicago, Ill., on April 9, President Thomas DeWitt Cuyler in the chair. Estimates of the needs of new equipment for the current year were discussed, and although no published report of the proceedings were made, the estimates gathered from all reliable sources showed that the necessary equipment amounted to 2,000 locomotives, 3,000 passenger cars, 1,000 baggage cars and 100,000 freight cars. The greater part of the cost of the new equipment is expected to be provided out of the appropriation in the New Transportation Act, while the resources of the railroads and the addition of new investors will, it is hoped, furnish the remainder. A special committee was appointed to cooperate with the Interstate Commerce Commission in the matter of continuing the method of payment of freight charges adopted during the period of Federal control, and progress was reported on the furnishing of data to the Commission preparatory to making such changes as may be deemed necessary in the future.

American Welding Society.

The first annual convention of the American Welding Society was held in New York, April 22. J. H. Deppler was elected president, J. N. Owens and D. R. Rushmore, vice-presidents. Papers were presented by C. A. Adams, ex-president of the society, William Spraragen, of the department of electrical engineering of the University of Washington, H. L. Unland of the Power and Mining Department of the General Electric Company and Stuart Plumly of the Davis-Bournonville Company. Mr. Spraragen presented interesting data on the amount of work that could be done in a specified time, giving average results for inside work, 1.8 lb. of metal deposited per hour, and in outdoor work 1.2 lb. per hour. Mr. Unland showed the details of the General Electric's approved welding methods in a number of stereopticon slides. The alternating current was recommended for beginners, as reports showed that better operators were obtained from among those who had been trained in the use of the alternating current.

The rapid growth of the society in numbers and influence is one of the best proofs of the admirable spirit of enquiry as to the best means and methods of developing the industry, and the desire of training experts in the welding art as they should be trained.

Books, Bulletins, Etc.

The Westinghouse E-T Airbrake Instruction Pocket Book. By W. W. Wood, Air Brake Instructor. Published by the Norman W. Henley Publishing Co., 2 West 45th Street, New York.

This is a new edition enlarged and revised containing the author's latest observations on the E-T air brake equipment, embracing the entire apparatus included in the engine and tender-brake, which, as is well known, has been reconstructed, and although the principle of the common triple valve is used to govern the graduation of the locomotive braking power in like proportion to the calculated power of the car brakes of the train, the general construction of this new equipment differs from the old, that it is practically impossible for one otherwise skilled in the details of the common quick-action and locomotive brakes to understand the E-T equipment without particular instruction. This book furnishes full instructions, and is profusely illustrated with colored plates and line drawings showing every detail, so that the careful reader can secure a complete mastery of the equipment, which is in some ways the most important detail of the air brake equipment. The work extends to 270 pages, is finely printed and well bound in cloth.

Locomotives for Logging Service.

The progress on the improvement of locomotives for logging service is shown in Bulletin No. 96, issued by the Baldwin Locomotive Works, and contains nineteen illustrations, including locomotives ranging from the six-coupled tank locomotives used by the Deer Island Logging Company, Deer Island, Oregon, to the Mikado type of locomotive employed by the Clear Lake Lumber Company, Clear Lake, Washington, the total length of engine and tender ranging from less than 50 tons to nearly 150 tons. The complete dimensions are furnished, and also details in their capacity to negotiate grades and curves, the whole forming a compendium of the adaptability of the modern locomotive to any kind of logging service. Copies may be had on application.

Lubrication of Locomotive Cylinders.

The April number of Graphite, published by the Joseph Dixon Crucible Co., Jersey City, N. J., reminds us that material improvement has been made in locomotive lubrication since means have been discovered by which selected flake graphite can be made to relieve oil of much of its duty. The benefit derived from graphite is particularly appreciated by engineers in charge of super-heater engines. The fine unctuous flakes of graphite are introduced into the valve chests through special feeders and are carried into the cylinders with the steam and distributed evenly on the walls and rods. Not much is required to produce noticeable results, for graphite is not destroyed by the heat. Increased efficiency and a saving in oil and fuel are reported by roads that have adopted the graphite lubricators.

The Portable Boats of Early Railroad Practice.

Record No. 97, issued by the Baldwin Locomotive Works, contains an interesting history of the above subject from the facile pen of J. Snowden Bell, and is another admirable example of Mr. Bell's painstaking labors in fields peculiarly his own, and but for his studious researches might pass into quiescence. The matter is of real interest as showing the difficulties that were overcome in the early days of interstate transportation. There are fourteen illustrations, each rare of its kind, and all forming a link in the story of transferring freight without breaking bulk over a line of alternate railroad and canal, the whole forming a record of engineering achievement that is a valuable addition to historical technical literature. Copies of the Bulletin may be had on application to the company's main office, Philadelphia, Pa.

Socialism and Our Colleges.

W. W. Atterbury, Vice-President of the Pennsylvania Railroad Company, delivered an address at the General Alumni dinner of the University of Pennsylvania recently, wherein he deplored the fact that young men in colleges are being educated by those who themselves have warped ideas of our national life. General Atterbury objects most earnestly to a university countenancing wittingly or unwittingly through consideration in its class rooms, any doctrine which encourages violations or the subversion of our form of government, or any change by other than constitutional and orderly methods. If this nation, or society itself, is to endure, it must be through the orderly evolution of thought and progress. The address is issued in pamphlet form and is having a wide circulation.

Strengths of Steel.

Professor F. B. Seely is the author of Bulletin No. 115 of the Engineering Experiment Station of the University of Illinois. It gives an interesting description of "The relation between the electric strengths of steel in tension, compression, and shear." The severe stresses to which carbon and alloy steels are put in some phases of engineering have developed a need for more detailed knowledge of the action of steel, under various types of stress, as well as of the factors which affect the physical properties of the material. The bulletin presents the results of experiments with six grades of steel and three alloy steels; namely, soft, mild, and medium carbon steel; and vanadium, nickel, and chrome-nickel alloy steel. Copies of the Bulletin may be obtained without charge, by addressing C. R. Richards, Director, University of Illinois, Urbana, Ill.

The Metric System.

"Drill Chips," the breezy organ of the Cleveland Twist Drill Company, Cleveland, Ohio, has very little to say in the April issue about boring holes, but it cuts the metric system of measurement to pieces in a way that makes delightful reading. If all the engineering periodicals and leading mechanical constructors had a writer like the editor of "Drill Chips," the metric system would be laughed off the face of the earth.

Railway and Locomotive Engineering

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The Evolution of High Speed Locomotives on the Railways in France*

In the history of the development of the locomotive, the year 1878, known as the year of the universal exposition, is one of exceptional importance. It was at this exposition that the first French locomotive with a bogie truck was exhibited, also the first application of continuous brakes and the first compound among the locomotives of the Mish company, you will understand why I have the best of reasons for considering that year as marking an epoch in the development of the locomotive, and why I will take the liberty of calling it the end of the middle ages and the commencement of modern times.

engines were deficient in adhesive weight, and by coupling two pair of drivers the adhesive weight was doubled. The Orleans company was the first to make use of high speed locomotives having two axles coupled. It began by increasing the heating surface, a part of which was accomplished by increasing the length of

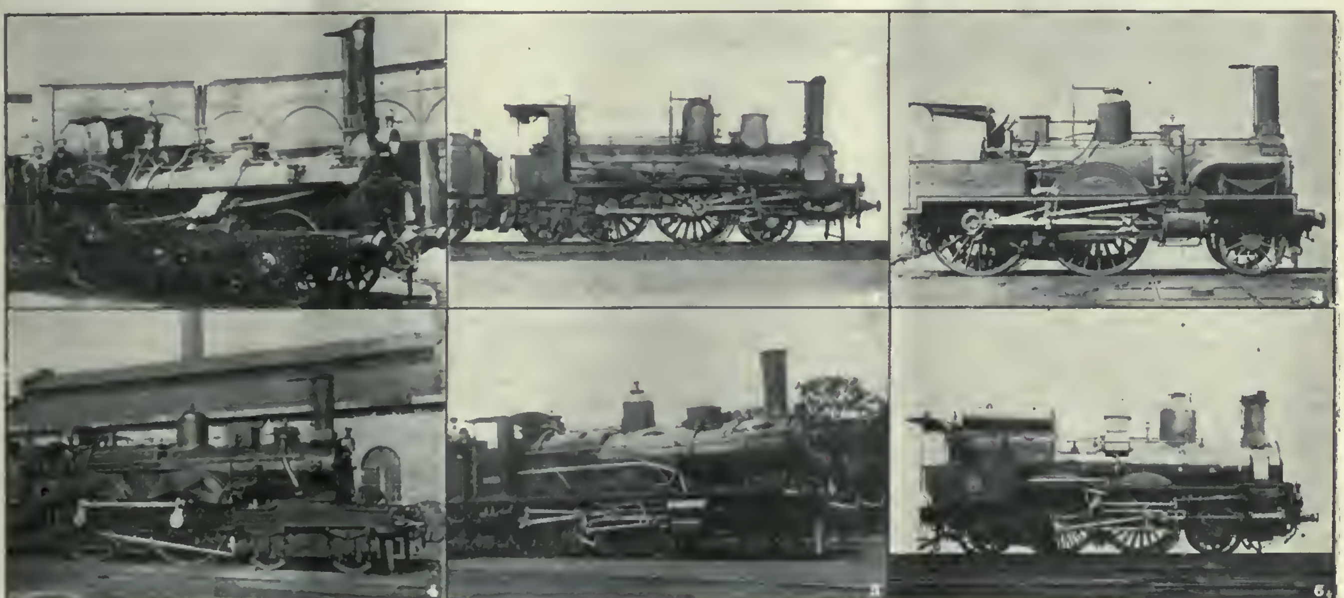


FIG. 1. CRAMPTON SINGLE DRIVER LOCOMOTIVE, 1852. FIG. 2. PARÍS-ORLEANS, 4-COUPLED EXPRESS LOCOMOTIVE, 1876. FIG. 3. MIDI 4-COUPLED EXPRESS LOCOMOTIVE, 1878. FIG. 4. "OUTRANCE" TYPE, 4-COUPLED EXPRESS LOCOMOTIVE, NORD, 1877. FIG. 5. DE GLEHM, 4-CYLINDER COMPOUND LOCOMOTIVE, BUILT FOR THE NORD, 1886. FIG. 6. PARIS, LYONS & MEDITERRANEAN 4-CYLINDER EXPRESS COMPOUND LOCOMOTIVE, 1889.

locomotive. It was in 1878 that free carrying wheels were definitely and wholly abandoned on express locomotives over the whole system of French railways. Finally it was in 1878 that the first number of the technical organ of the railway companies appeared, the *Revue Générale des Chemins de Fer.* If I add that it was in 1878 that I made my debut

In speaking, however, of the remarkable progress that has been made I will limit myself to the consideration of the high speed locomotive.

The early engines, with one pair of driving wheels and two free carrying wheels, as illustrated by the Crampton engine (Fig. 1), were capable of running at a high speed, one with 90½ in. drivers having attained a speed of 116 miles per hour in a test made in 1889. But these

the tubes to 16 ft. 4⅞ in. between the tubesheets. Afterwards, because of placing a fourth axle back of the firebox for the purpose of doing away with a troublesome overhang, they were able to increase their grate area from 15 sq. ft. to 18.4 sq. ft. And this, for the times, was considered a very remarkable locomotive. It is shown in Fig. 2.

In order to avoid the addition of a fourth axle, and, at the same time, limit

*Abstract of the presidential address by M. A. Herdner before the Society of Civil Engineers of France.

the overhang, the Est, Midi and Nord companies confined themselves to previous practice for increasing the grate area, and with it the firebox, while retaining the length of tubes and their heating surface as illustrated by the Midi engine (Fig. 3). And then, in order to increase the stability of their latest "Outrance" locomotives, the Nord decided to apply a bogie truck as shown in Fig. 4 instead of the plain carrier axle previously used. But the opportunity was not embraced, at that time, to increase the heating surface by lengthening the tubes.

These different designs of boilers led to a fixing of the ratios of grate area to heating surface, a thing that was unknown at that time in France. For the empirical formulae used at the time were quite inadequate, as they expressed the evaporation as a function of the product of the heating surface by the grate area. As if it were possible to vary these two quantities with impunity!

The same divergence in practice practically assumed that very long tubes increased the efficiency per pound of fuel, while short tubes increased the efficiency per sq. ft. of grate. Between 1885 and 1890 M. Henry conducted an investigation at the Lyon shops, to determine as to just what might be the influence of tube length on evaporative efficiency—an investigation which is now classic.

A second means of increasing the power of the locomotive consisted in raising the steam pressure. Still, in 1878 the increase was made with prudent slowness. From 92 lb. per sq. in. in 1845 it had risen to 100 lbs. and 120 lbs. per sq. in. at the expositions of 1857 and 1867 respectively. On most of the locomotives shown in 1878 it did not exceed 127 lbs., for of all the locomotives exhibited those of the Nord and of the Upper Italian were the only ones working under a pressure of 140 lbs. Progress then became more rapid a dozen years later when it became possible, in the regular course of manufacture, to make sheets capable of sustaining these pressures.

Before 1878, with the exception of some fruitless experiments by Watt, the only attempts made to increase the efficiency of the locomotive was by the use of the most theoretically perfect valve motions, especially those using two valves like the Gouzenbach, Meyer and Polonceau gears, to cite only those originating in France. But of all the locomotives, foreign as well as French, the only attempt to increase cylinder efficiency was found in a modest six-coupled machine, designed by M. Mallet for the small road running from Bayonne to Biarritz. It was a compound engine and a bold innovation which was characteristic of that great engineer. But M. Mallet was never a prophet in his own country, as his example was first followed abroad, especially in England and Russia.

The first four-cylinder locomotive run in France was one built for the Nord at Belfort by the Société Alsacienne de Constructions Mecaniques, after the design of M. de Glehn. This engine (Fig. 5) was built for experimental purposes and remained the only one of its kind. It was a high-speed engine having two pairs of independent drivers, one pair being driven by two inside high-pressure cylinders, and the other by the two outside low pressure, set somewhat back of the former. It had a grate area of 24.4 sq. ft. and carried a working pressure of 156 lbs. per sq. in. and for twenty years it was the most economical locomotive on the Nord system.

This engine was put into service in 1886, and between that date and 1888 was subjected to numerous tests, and then appeared in a transformed condition at the exposition of 1889, by the substitution of a bogie truck for the carrying wheels that had, before that, been under the front end.

The complete independence of the high and low-pressure motors which distinguished this engine reflected an opinion extensively held by the old builders. They thought that the coupling of driving wheels made an enormous increase of resistance, and they used it reluctantly on all high-speed engines, considering the distribution of the power of the two sets of cylinders between the two pair of drivers as quite justifiable. M. Henry, however, was of a different opinion and thought that the disadvantages of coupling were more than compensated for by the advantages obtained from the standpoint of the utilization of the adhesive weight, the rapidity of starting, the regularity of the work of the cylinder and the balancing of the moving parts. So, when in 1887 the Lyon company decided to build a four-cylinder high speed locomotive, having two driving axles, the wheels were coupled. This engine is shown in Fig. 6, and was exhibited at the exposition of 1889. It differed from the Nord machine (Fig. 4) in that it carried a steam pressure of 212 lbs. per sq. in., also in the number of carrying axles, which were arranged like those of the earlier engines, by the overhang of the four cylinders and finally by the connection of their valve motions, which were controlled by a single reversing gear. But, as in the case of the Nord engine, this Lyon machine was not reproduced, but in subsequent construction the two systems borrowed the best points developed by the other.

Thus it happened that, at the Chicago exposition of 1893, the Nord exhibited a locomotive carrying a steam pressure of 200 lbs. per sq. in. with the four drivers coupled. Then in 1892 the Lyon company put an engine in service in which a bogie truck was substituted for the front carrying wheel of Fig. 6.

Such was the genesis of that remarkable system of four-cylinder compounding with two separate pair of driving wheels, which is known abroad as the French system. It was afterwards extended to three, four and even five axles coupled. Up to January 1, 1915, it had been applied on all six of the great railway systems of France and to about nine-tenths of the locomotive equipment.

The essential characteristics of the Nord locomotives were afterwards reproduced by the Midi (Fig. 7), the Ouest, the State, the Orleans and the Est companies. So it happened that at the exposition of 1900 five high speed French locomotives were grouped together that were identical in system and which differed only in detail.

But railroads cannot escape the fate of other industries, which requires that there shall be a constant change made in their equipment. And so it happened that scarcely four years had passed since the building of the Nord engine exhibited at Chicago before it was found necessary to make an increase of grate area of 12 per cent. Then after a period of four years more there was a fresh increase of 20 per cent. But the additional weight of boiler involved in this increase was too great to be put upon the four axles of the original type, so that a fifth was added, which was placed beneath the firebox back of the rear drivers, as shown in Fig. 8. Thus the first double expansion Atlantic locomotive to be seen in France was built.

A few years later the Midi and Orleans companies, which had adopted the same type of engine, still further increased its power, by enlarging the 29.7 sq. ft. of grate area of the Nord to 33.14 sq. ft. on the Midi and to 33.36 sq. ft. on the Orleans. At the same time the weight of 33 metric tons on the drivers of the Nord engine became 35 metric tons on the Midi and 36 on the Orleans. A ministerial order of January, 1915, increased the permissible axle load, which, at that time, was limited to 18 metric tons. In building its Atlantic locomotive, the Orleans company had, consequently, exhausted its reserve of adhesive weight.

The four axled engine, although greatly superior to those previously built, had absorbed the major portion of its reserve, leaving only a small margin available for further development. Hence the reign of the Atlantic was very ephemeral, and the use of a fifth axle began at once to manifest itself, and a number of companies preferred to couple it to the drivers in order to insure the supplementary adhesion required for starting.

With this coupling of the third axle the high speed locomotive entered upon a new phase of its evolution. Already the power of the old engines had been practically tripled in the Atlantic.

The first engines of this type, that is, with six wheels coupled, to be run in France were put into service between 1901 and 1903 by the Ouest company, the Est and the Paris, Lyon and Mediterranean. The Ouest engine is shown in Fig. 9. It carried a steam pressure of from 212 lbs. to 227 lbs. per sq. in. and was fitted with grates having areas of from 26.36 sq. ft. to 32.28 sq. ft., but they were no more powerful than their contemporary Atlantics. But, like the earlier engines with four wheels coupled, they did have a reserve of adhesive weight which guaranteed a regularity of service on undulating lines, but which could not be utilized on low grade main lines.

The problem of thirty years before thus arose anew. Again it was necessary to establish an equilibrium between the power of the machines and their adhesive weight, which latter had been suddenly increased 50 per cent. by the coupling in of the third pair of wheels. As years before, the first thing done was to increase the evaporative efficiency of the boilers, but, taught by experience, they looked particularly to the increase of grate area. In 1905, in the ten-wheeled engine shown in Fig. 10, the Est raised its grate area from 30.77 sq. ft. to 34 sq. ft. The increase was about 10 per cent, but the resulting power was barely sufficient to meet the requirements of the traffic. Soon afterwards the State, the Midi, the Paris, Lyon & Mediterranean and the Orleans adopted grate areas of 43 sq. ft., 45.73 sq. ft. and 46 sq. ft. This was an increase of about 33 per cent. over grates previously used. It was only when the difficulties of firing prevented any further increase in length that they turned to the widening of the grates and did away with the established firebox located between the frames and adopted the wide firebox, already in use from a different motive on the Belgian State Railways. And as this firebox could only extend beyond the frames back of the coupled wheels, it was necessary to carry it on an additional pair of wheels. In the language of our American friends, the high speed locomotive, with six wheels coupled, passed, by this addition, from the category of the ten-wheeled to that of the Pacific, which is characterized by the use of six wheels coupled, located between a bogie truck at the front and a carrying axle at the rear, as shown in Figs. 11 and 12.

The necessity of placing the coupled wheels between the firebox and the cylinders and of giving them a sufficient load led to a marked increase in the length of the tubes and so favoring, even more than was desirable, the economic efficiency of the boiler to the detriment of its power. This has been remedied by taking a convenient diameter for the tubes and doing away with the internal wings of the Serve tubes.

The use of the overhanging grates resulted, on the one hand, in the elevation of the center of gravity of the suspended weight of the locomotive in a way that increased their stability, as demonstrated by Mr. G. Marié.

An increase of pressure was not included in the plan. This had been raised to 227 lbs. per sq. in. in 1900 and was in general use on the Atlantic locomotives, and the experience which the companies had had with them was such that the conclusion was reached that the increase of power due to an increase of pressure was not enough to compensate for the extra stresses put upon the boiler and the increase of maintenance expenses resulting therefrom.

On the other hand, the superheating of the steam, by which the cooling effect of the cylinder walls was overcome, had attracted the attention of traction officials, and tests were started on the several systems to determine as to what part it could be made to play in the development of the high-speed locomotive with six wheels coupled and whether it would play the capital role that compounding had played in the development of the four-coupled locomotive. But it was not until about 1890, thanks to the efforts of M. Emile Schwoerer, formerly secretary to Hirn, that the matter was definitely undertaken.

Before 1870 compounding appeared quite as advantageous, from a thermic standpoint, as the moderate amount of superheating then in use. This was especially true when the decrease in the moving parts, the lower pressure on the valves, the decreased loss of efficiency brought about by the greater tightness of the packings, the better utilization of clearance spaces and the more constant turning moment was alone considered. On the other hand the successful use of superheated steam was intimately connected to the arrangement made to insure tightness of the different parts and the proper lubrication of the rubbing surfaces that were exposed to the steam on the other. These were delicate problems whose difficulty increased with the temperature of the admission steam, and which were only solved after a long trial.

The practical difficulties were finally solved, and the superiority of superheated steam from the thermic standpoint was incontestable, and then the question arose as to whether compounding should be abandoned or whether the two systems should be used in conjunction with each other. But at the Berne Congress in 1910 the return to single expansion engines was advocated by the engineers of the Belgian State Railways, who had in service some superheated steam engines of single expansion and four equal cylinders. The great majority of the French engineers were opposed to this view. The Paris, Lyon & Mediterranean company decided to test the matter and built two Pacific locomotives, one having four independent cylinders, and the other (Fig. 11) having four cylinders compounded. A saving of 9 per cent. stood to the credit of the compound and superheat combination.

With this admitted, the question then arose as to whether it would be better to superheat the steam completely before admission to the high pressure cylinders, or to superheat a second time before admission to the low pressure cylinders. This time the Est undertook the investigation and the results were not favorable to the intermediate superheating. It was found that, under the ordinary conditions of practice, when the superheated steam left the boiler at a temperature of 650° Fahr., it still retained an appreciable amount of superheat when it left the low pressure cylinders.

Are we in a position, then, to say that the most recent designs of Pacific locomotives, all of which are compounded and provided with a single superheater, are necessarily the best? Such a conclusion would at least be premature, for the question rests upon knowing whether the addition of a superheater to a locomotive ought not to be the occasion of doing



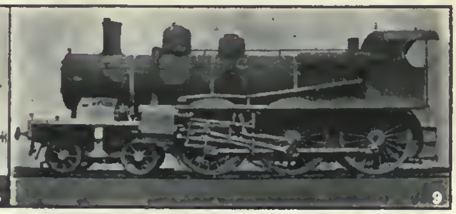


FIG. 7. FOUR CYLINDER, FOUR-COUPLED EXPRESS LOCOMOTIVE OF THE MIDI 1896. FIG. 8. FOUR-CYLINDER COMPOUND ATLANTIC LOCOMOTIVE OF THE NORD, 1900. FIG. 9. TEN-WHEELED EXPRESS LOCOMOTIVE OF THE OUEST RAILWAY, 1901.

away with a mass of complications which are not without presenting their real difficulties. All other things being equal, two cylinders are more economical than four, not only because the passive resistance increases with the number of moving parts, but also because the cooling surfaces, with which the steam comes into contact, increases as the number of cylinders are multiplied.

The maximum efficiency ought to be obtained by the use of a single superheater, a single high and a single low pressure cylinder. Unfortunately, this solution, which the Nord made on a freight locomotive, cannot be applied to high-speed locomotives because of the clearance limitations of the right of way. We are forced, then, to choose between the simplicity of two-cylinder machines and the advantages which can be procured when superheating is superimposed upon compounding. But the difficulties of maintenance and operation have been such with the compound system that a tendency has recently manifested itself, on several of the French railways, in favor of a return to the two-cylinder arrangement, which has always been maintained in England and the United States. It has only been the high-speed locomotives that have heretofore resisted this tendency. Being desirous of settling this question the Midi company ordered four Pacific engines in 1913 which were to have had two cylinders and which were to have been run opposite similar locomotives having four cylinders compounded. The war, however, interrupted these experiments, but it is possible that they may now be built and that we will be able to tell as to how far this construction will respond to our expectations.

One last question remains to be answered. What have we gained by the substitution of three six-coupled wheels for four, and the Pacific for the Atlantic type of engine?

Between 1908 and 1914—and there is no need of explaining why we stop at the latter date—the running time of six principal trains between Bordeaux and Cette was lowered 50 minutes, or 11 per cent; between Paris and Marseilles, 22 minutes, or 3 per cent.; and, on other runs from one to four minutes, or from .5 to 2 per cent. The running speeds have risen but very little, that is, from 51 to 52 miles per hour, or only 2 per cent. On the other hand, the weight of trains hauled has increased from 30 to 44 per cent., and as the general arrangement and weight of cars have changed but very little, the number of seats in the same train has increased in almost the same proportion. Such an increase has, of course, been to the advantage of the public.

While this paper has been limited to the development of the express locomotive, the benefit of the improvements that have been made in it has extended to all types of engines, and whatever improvements have been made in either freight or passenger service due credit must be given to the Alsatian School. But hereafter it is apparent that no engine will be built, for any service, having two cylinders only and using saturated steam. As for the locomotives of old construction they are being either scrapped or rebuilt.

Railroad Labor Board.

The recently appointed Railroad Labor Board after organizing and holding sessions in Washington, D. C. for several weeks has removed to permanent headquarters in the Kesner building, Chicago. Delegates representing the railway brotherhoods and members of other organizations have already secured hearings before the Board, and decisions in regard to the demands for increased wages are expected early this month. The general impression seems to be that the Board is showing a degree of activity altogether unusual in governmental boards, and it is to be hoped that the good work will be kept up. The appointees, of whom we gave a brief record in our May issue, are all apparently well qualified for the work by reason of previous activity in labor and other disputes, and all vouched for by those in a position to form a just opinion as being men of high probity and character of the best.

It will be admitted that a board constituted of men of such experience, and all of unimpeachable record, have the appearance at least, of being well-equipped for the work in hand. That it is impossible to satisfy every demand that will be made upon them is a foregone conclusion. At the best their decisions cannot be other than compromises. In the very nature of things the burden will fall upon the three members representing the public, but the others are, for a time at least, free from the entangling alliances of domineering committees whose attitude has paralyzed many attempts at conciliation in the past, and who, we hope will pass into quiescence and allow the Railroad Labor Board the same freedom of action and a measure of the same respectful acquiescence that is accorded to the work of the Supreme Court of the United States.

Ole Hanson on Government Ownership.

In a recent speech before the New England Association of Gas Engineers, Ole Hanson, the former mayor of Seattle, set forth his ideas as to the economic value of the government ownership of railroads. He said that, when he became mayor he believed that the only outcome of the agitation in relation to street railways, and probably electric power, was municipal ownership. He had come to the belief that the public was so prejudiced against public utility corporations that it would not give them a square deal; but, later, after the city had assumed control of the street railway lines, he came to believe that they were not as efficient or as fair in their charges and in the working of the municipal facilities as they could be. And then, after seeing the Seattle public utility made the football of politics, he sums up with these conclusions:

I have come to the conclusion that there is but one way to operate the great public utilities and railroads of this country, and that is that the public must be so educated to understand exactly what the public utilities are up against and must be taught to be fair.

I think every advantage should be given for the conduct of private enterprise and it should be allowed to remain in private hands.

I think that whatever economies a government running a railroad is allowed to make, whatever correlation or combination the government, for instance, has made which has brought about savings in the government operation of railroads, the private companies should have the right to correlate, to combine and to operate.

I believe that with public encouragement we can get our public utilities operated properly. I believe, on the other hand, that the public must be protected from extortion and from poor service.

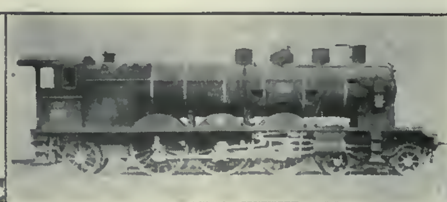



FIG. 10. TEN-WHEELED EXPRESS LOCOMOTIVE OF THE EASTERN RAILWAY, 1905. FIG 11. PACIFIC EXPRESS LOCOMOTIVE OF THE MIDI RAILWAY, 1908. FIG 12. PACIFIC EXPRESS LOCOMOTIVE FOR THE PARIS, LYONS & MEDITERRANEAN RAILWAY, 1912.

Special Test of a Service-Release-Emergency Brake Application of the Automatic Straight Air Brake on the Virginian Railway

In our issue for May we published a description of the operation of the triple valve of the Automatic Straight Air Brake Co. We now publish the records of an interesting test of the valve made on a 100-car train on the Virginian Ry. It will be remembered that, in the preparation of this train for these tests each of the hundred cars was fitted with a trainagraph. This apparatus registers the pressures existing in the train-pipe, brake cylinder and auxiliary reservoir at all times. The registration is made on a strip of paper traveling at a speed of about ½ in. per minute, and the records obtained with them have been of invaluable assistance in the study of the action of the brake.

Prior to the equipment of the 100-car rack and train with this complete installation of trainagraphs, it was impossible to reach any definite and demonstrable conclusions as to the comparative action of air brakes upon the rack and upon the road. But with every car fitted with this recording device, by which each could be studied in detail and compared with all of the others in the train, it has been shown that the results obtained in these rack tests and with full 100-car trains, either standing or in motion are strictly comparable. And that results obtained with this triple at least, under one set of conditions can be duplicated in any of the others.

Among the most spectacular of the tests that were made with the 100-car train was a standing test. It was intended to reproduce the conditions that might readily occur running on the road, where an engineer had made a service application for the purpose of reducing speed and, this having been accomplished, he released his brakes, and was then suddenly confronted with a danger that required an immediate emergency application.

To reproduce this condition there was first made an abnormal service brake pipe reduction of 35 lbs. and then the resultant brake application was held on for a little more than five minutes. Then the engineer's valve was moved to and held in full release position for 10 seconds, after which time, an emergency application was made.

Those who have followed the description of the operation of the A.S.A. triple valve will recollect that, in the service application, no air is drawn from the auxiliary reservoir so that the full reservoir was available for the emergency application.

The diagrams of this test, here reproduced, are exact copies of the trainagraph records for a number of cars in the train located at approximately uniform intervals, except at the front and near the seventieth car.

The upper line of the diagram represents the brake cylinder pressure. The intermediate diagram line that is straight horizontally for some distance from the left hand side, indicates the auxiliary or emergency reservoir pressure and the lowest diagram line, which varies in the same manner as the brake cylinder pressure indicates the brake-pipe pressure.

Let us take the diagram of car No. 1, for direct study. The first pressure to appear in the brake cylinder was about 45 seconds after the 10 minute mark. This pressure was increased by successive brake-pipe reductions until at the 13 minute mark a pressure of nearly 60 lbs. was reached.

Then there was a partial release followed at 15 seconds after the 16 minute mark by a full release, immediately followed by going to a full emergency, followed in turn, 30 seconds later, by a full release.

Meanwhile the line of brake-pipe pressure shows the successive reductions by which the brake cylinder pressures were produced, followed by a building up of that pressure to the normal, then came the fall to zero, caused by the emergency application with a comparatively rapid increase to normal or the final release of the brakes.

During the period of service application the pressure in the auxiliary reservoir has remained constant as indicated by the straight horizontal line.

In order that the lines of the trainagraph pens might not overlap and interfere with each other the auxiliary reservoir pen was set the space of about one minute back of the brakepipe pen, which accounts for the seeming lack of synchronism between the two.

So the auxiliary reservoir pressure remained constant until the brake valve handle was moved to full release position when there was a little puff of air emitted, caused by the operation of the triple. This lowered the pressure momentarily but it was quickly recovered and then when the emergency application was made the auxiliary reservoir pressure fell at once to equalize with that of the brake cylinder.

As might have been expected, the auxiliary reservoir pens on some of the trainagraphs failed to mark during a portion of the test, but where they did mark the same characteristic of a uniform pressure during the service application is to be seen.

As already stated the brake valve was put into the full release position for 10 seconds before the application of the emergency.

Following the trainagraph records through the train, we see that a full release of the brakes was obtained on the front end of the train back to the eleventh car, because of the start that the release had over the emergency application. At car No. 21, however, the full release was not quite reached before the emergency overtook it, when the brake went to full emergency application.

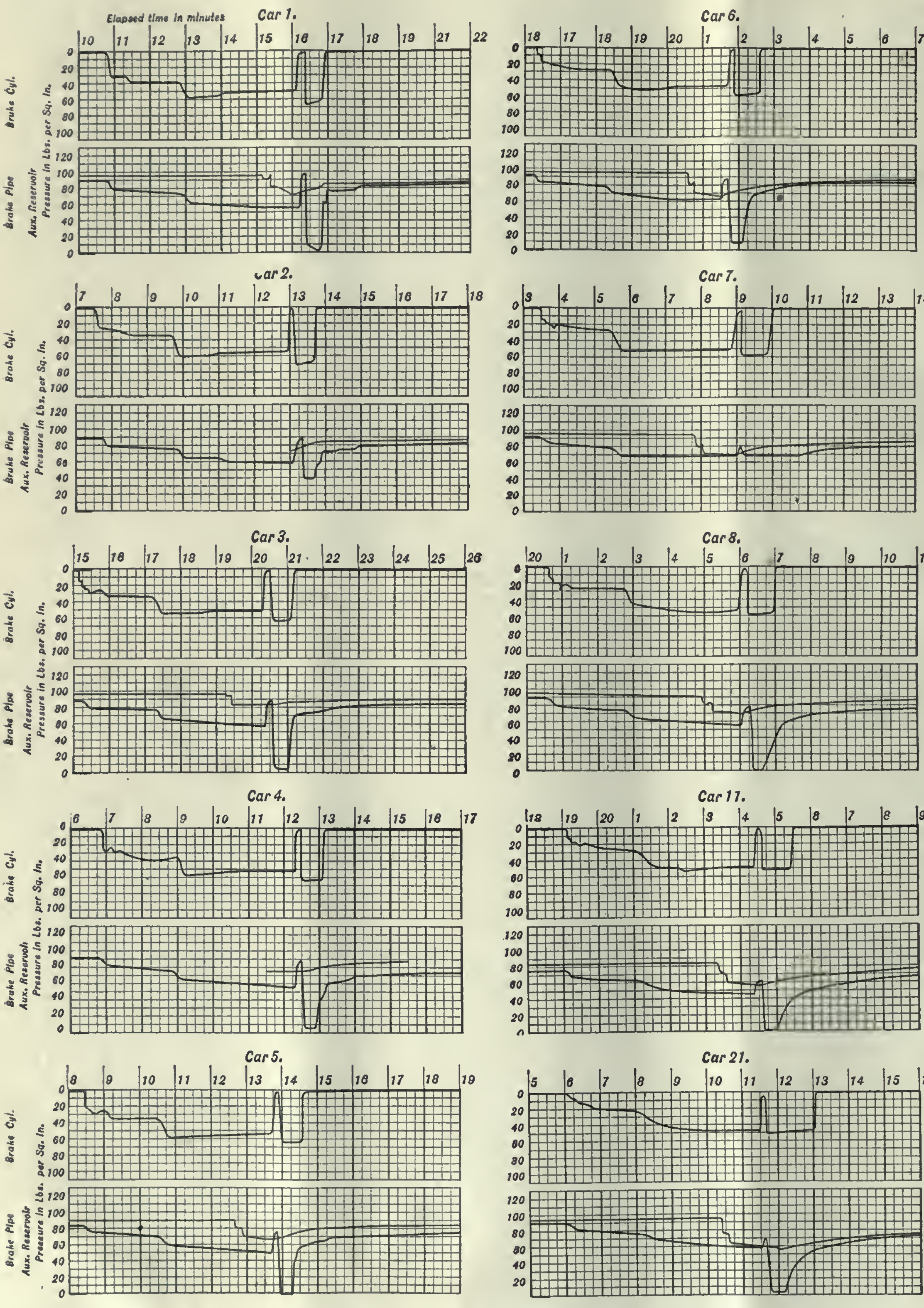
On car No. 41, there was a still greater fall-off and this failure to reach full release becomes more and more pronounced through cars Nos. 61, 65, and 68. At car No. 69, the brake had just started to release when the emergency was upon it, and at car No. 70 the emergency application had overtaken the release and from that car on to the rear of the train there is no sign of any release, and the diagrams look as though an emergency had been made during the period of service application.

Owing to the impossibility of so adjusting the trainagraphs on each car that they are in exact time accord as represented on their sheets, the distance back upon the train at which the release had begun to take effect when the emergency application was made on the engine can not be accurately determined but from the serial action of the release of the same train on other tests this point can be located with a close approximation.

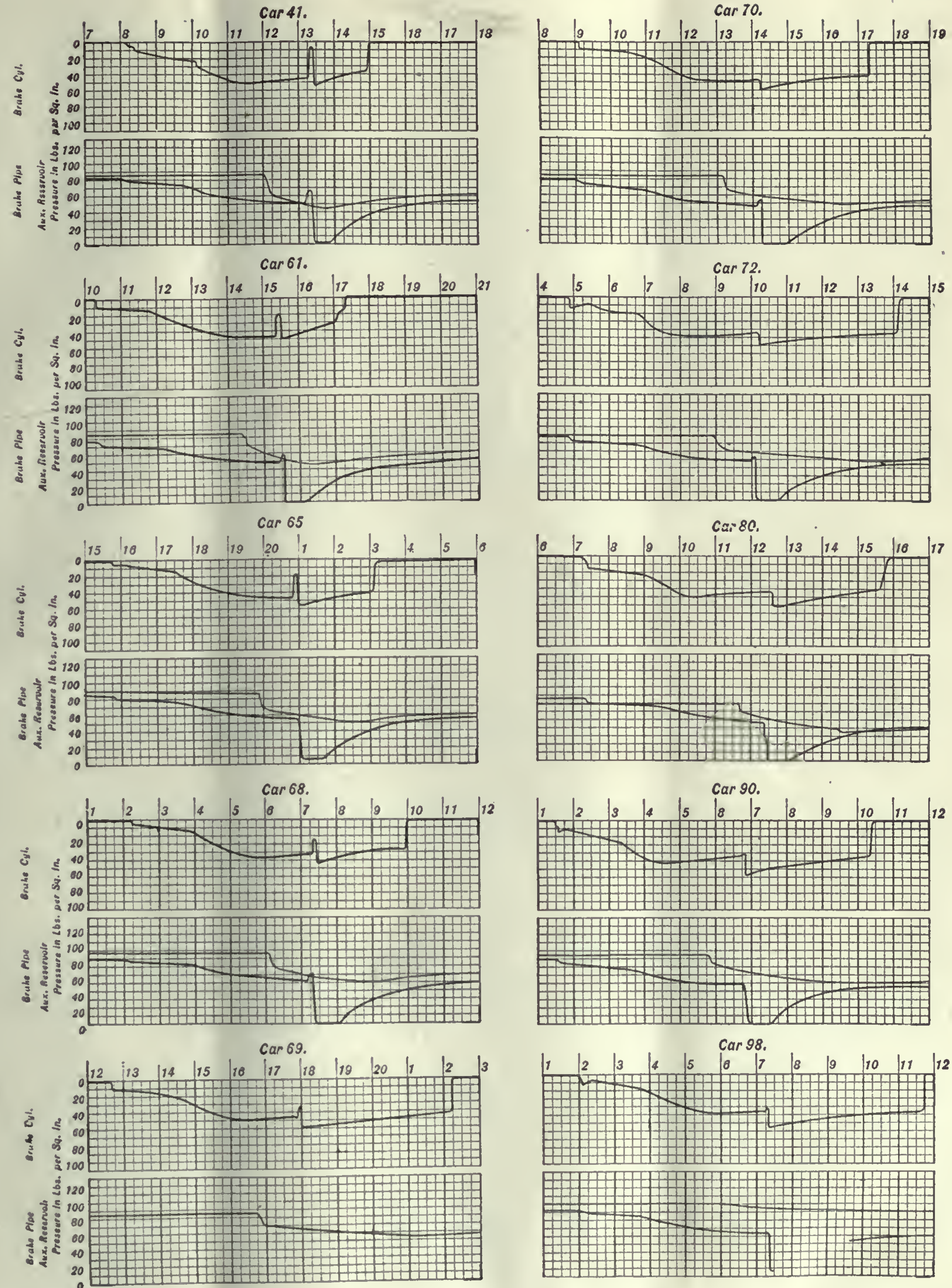
From an average of other tests the first car can be taken to have released about five seconds after the brake handle had been put in the release position and the fiftieth car in about 10 seconds after the first car so that, in this test, it is probable that the release had reached the twenty-fifth car at the instant the brake valve was put in the emergency position.

At that instant the flow of air into the brake pipe to effect the release was cut off, and in its place there was left merely a wave of high pressure or impulse traveling toward the rear of the train. This impulse was traveling at high but at a gradually reducing velocity.

Back of it came the outflow of air caused by the emergency opening of the brake-pipe. An outflow that lowered the pressure as each succeeding car felt its effect and emptied its auxiliary reservoir into the brake cylinder.



BRAKE PERFORMANCE DURING A SERVICE APPLICATION FOLLOWED BY BRAKE VALVE BEING PLACED IN FULL RELEASE POSITION FOR 10 SECONDS, THEN FOLLOWED BY AN EMERGENCY APPLICATION.



STANDING TEST OF 100-CAR A. S. A. TRAIN. VIRGINIAN RAILWAY, PRINCETON, WEST VIRGINIA, ON JULY 2nd, 1918.

(Reproduced from Trainagraph Records.)

It was a race from the front to the rear of the train between the impulse of release and emergency; with that of the release having had a start of 10 seconds and of about 25 cars.

Here, then, is a visual representation of the race through the whole length of the 100-car train between the release and an emergency application, in which the latter proved itself the swifter of the two.

The records of the two service applications show how they affected the brake application back to and including the one hundredth car. The effect of brake-pipe friction in easing off the reduction of its pressure with the consequent softening of the rate of brake cylinder application is most clearly shown. And, in it, is developed the fact that on the ninety-eighth car a brake cylinder pressure of about 49 lbs. had been obtained though lessened to about 46 lbs. by leakage at the moment of the emergency as against a corresponding pressure of 58 lbs. and 50 lbs. on the first car, the latter being that at which the brake started to release.

As the train was standing when the test was made, there is no record of shock or other disturbances. But is is comparatively easy to show, from other records of the action of these brakes on a 100-car train while running and at various speeds that there would have been no injury sustained had this test been made on the train in motion.

In the first place, in the emergency application of the brake that occurred on the run between Princeton and Roanoke on July 4, there were no shocks delivered to the caboose or engine. Nor was there any shock produced by any releasing of the brakes.

In the test under consideration we have the same brake cylinder pressures, at the end of the service application barring a slight variation due to leakage, back to the last car. So that the retardation throughout the whole train would have been practically uniform.

Then came the release dropping the brake cylinder to zero at the front of the train and reducing it serially back to car 69. The difference in brake cylinder pressures, at the instant of the emergency application, between cars 11 and 70 was about 45 lbs. The trainagraph records shows that this was evenly divided from car to car so that the difference in brake cylinder pressures between any two cars was less than one pound. This could not have produced any shock. And, finally, the difference in the emergency pressures of the first and last cars was less than three pounds.

Hence it is evident that no shock or injury could have happened to this train had the test been made while it was in motion, regardless of the speed at which it might have been running.

So in this instance, at least, what has heretofore been regarded as impossible has become an accomplished fact and capable of every day and safe repetition.

Another test of the same character was made with two forces meeting in collision, as it were.

A service application had been made, followed by a full release. Just after the release had started back from the engine, the angle cock at the rear of the last car was opened making an emergency application at that point. This started for the front of the train and, meeting the release wiped it out of existence and persisted in its forward movement until it had reached and applied the brake on the engine. Thus making an emergency application of the brakes in the face of the full force of the inflowing air with the engineer's valve in full release position.

These are notable characteristics of the new triple valve, and illustrate two spectacular performances that have been given with it.

Annual Convention of the Master Boiler Makers' Association.

The reports presented to the Master Boiler Makers' Association at its annual convention in Minneapolis last month were noticeable for their brevity, which is a rather estimable quality. Many of them were more or less perfunctory, but the statement of the case was usually quite definite. For example, in the report on the best firebox steel, it was merely a matter of deciding as to the proper range of tensile strength. The recommendation made was in accord with the specifications of the Master Mechanics' Association that the range be from 55,000 lbs. to 65,000 lbs. per sq. in. Incidentally attention was called to the character of the breakage of the side sheets in the form of cracks at the stay-bolts and long vertical cracks along the center line of the sheets. And then there is added a restatement of the old experience "that long life of fire steel is to be obtained by suitable treatment of water supplies, a proper arrangement for delivering feed water into the boilers and proper method of caring for boilers in engine houses," points that the association has been insisting on for years.

There is one report that gave a very interesting summation of data collected. It relates to the comparative breakage of staybolts in boilers generating superheated and saturated steam. As a result of the investigation it appears that there was a marked falling off in staybolt breakage where superheated steam is used. In the case of 26 boilers generating superheated steam the average number of staybolts broken per year for five years was 17.19 per boiler, while for 30 boilers generating saturated steam the average annual breakage was 36.73 staybolts. This, however, was not attributed merely to the superheated steam, but rather to the fact that there was a decrease of steam pressure. The average steam pressure on the superheated steam boilers was 192.5 lbs. per sq. in., while that of the saturated steam boilers was 220 lbs.; the difference in the staybolt breakage being attributed to this difference.

Incidentally the report states that a comparison was made in the case of 10 locomotives operated with saturated steam and without a brick arch. "These locomotives were later equipped with super-heaters and a brick arch, the pressure remaining the same at 205 lbs. per sq. in. The comparison shows considerably less staybolt breakage. The reduced breakage of staybolts is accounted for along these lines. The brick arch acts as an indicator, making the proper handling of the boiler compulsory. If the boiler is blown down too soon arch tubes will be distorted. Saving the arch tubes also saves the staybolts."

Things were not quite so decisively stated in the report on the necessity of using a cinder hopper on the smokebox. It simply said, in so many words, that if the front end were to be so designed that, with the fuel used, it would clear itself, then the hopper was unnecessary, while, if it would not clear, the hopper is a great convenience. As for the self-cleaning feature, it stated, what some of us learned many years ago, that the character of the fuel has an important influence on the ability of the front to clear itself.

The report on the flanging of firebox sheets in a press was the shortest of all, and here it is: "The flanging of firebox sheets on a flanging press is not detrimental. It is a matter of the proper heating of the material. Cold flanging can be successfully employed on round heads and straight sides of flue and door sheets in all types of fireboxes."

In discussing the value of the Prime washout plug, it appears that its chief advantage lies in the fact that, being made of brass and malleable iron with very little brass, it contains so little brass that it is not worth stealing, while all brass plugs must be watched or screwed tightly into place to prevent theft.

Finally, the committee reporting recommended the use of the Madden ashpan.

The report of the secretary gives the total membership in good standing, active, associate and honorary, as 363.

At the 1921 convention the association will receive reports and discuss methods of safe-ending boiler tubes, the hot water boiler washing system, crown stays, the deterioration of firebox sheets behind grate bars and supports, the cracking of boiler shells at the girth seam rivet holes, the various types of side sheets, repairing mud rings without removal and oxy-acetylene and electric welding.

Annual Convention of the Air Brake Association

Reports Showing the Need of Better Maintenance and Improved Methods in Repair of Equipment—Addresses, Reports and Election of Officers

The Air Brake Association held its twenty-seventh annual convention at the Hotel Sherman, Chicago, Ill., beginning on May 4, and continuing its sessions for four days, President T. F. Lyons, of the New York Central R. R., presiding. In the course of his opening address, Mr. Lyons emphasized the fact that since the return of the railroads to their owners the railroad administration could no longer be held responsible for any delinquency occuring in air brake or other matters. Neither could any of the influences growing out of the war period afford excuses for any shortcoming in the work in which they were engaged. On the contrary it is well to remember that during that trying period the administration has afforded every facility for holding the annual meetings of their association while many other meetings of associations were temporarily suspended. The excellent work of the committee and individuals looking toward the annual work of the convention was the best proof that the high aims of the members of the Air Brake Association, aiming always perfection in their calling, were being maintained.

Frank McManamy, manager department of equipment, division of liquidation of claims, Railroad Administration, also addressed the convention and paid a warm compliment to the members on the excellent work that they had accomplished, and the valuable suggestions that had come from them, more than the government had been able to put into practice, but which he was confident would not be lost sight of if the united support of the higher officers was ungrudgingly obtained, and the abiding interest and thorough discipline of the employees maintained. Mr. McManamy urged the necessity of a more universal and systematic method of training air brake experts to the end that a large number of thoroughly trained men could be equipped for the service. A higher standard of integrity between employers and employees was also essential to the end that all might work for the common welfare.

Better Maintenance of Air Compressors.

Mark Purcell, general air brake inspector, Northern Pacific railroad, read a paper on the above subject which had been approved by the Northwest Air Brake Club, in the course of which it was claimed that while the usual impression is that compressors are giving good service, at the same time service records show a large amount of wheel sliding and breaking in two of trains that, from first analysis, would not appear to have any relation to, or to any extent be due, to the manner in which the compressors are operating, and yet careful, or even casual investigation, develops in many cases, that the compressor is largely responsible for the trouble. If a compressor runs slow, or for any reason raises pressure slowly, there may not be enough air accumulated after a brake application is made, and the engineer, necessarily being anxious to avoid delay, attempts to release and proceed, with the result that a part of the brakes only are released and wheels are slid or drawbars pulled out; and with passenger trains, passengers are annoyed and sometimes injured by rough handling of the train, and still the compressor has not stopped and refused to work.

T. F. LYONS

Most of the low efficiency and some of the failures are due to lack of repairs, or the quality of the repairs made being below, only slightly, the standard required. In some cases it is an error in a single feature, but more often a combination, such as a number of leaks, any of which may be too slight to cause trouble, yet when combined are serious. The above applies more particularly to compressors having steam and air cylinders compounded, on account of the balancing effect that may be caused by leakage.

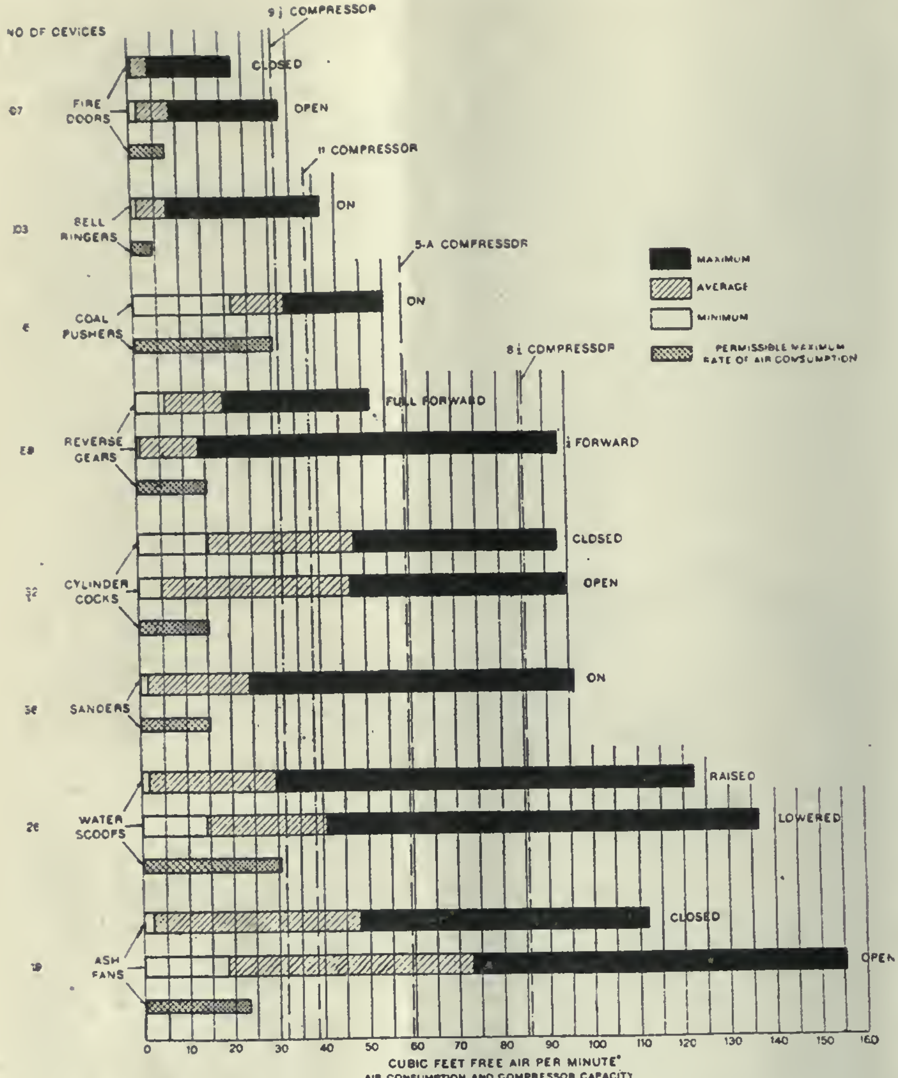
It is not uncommon to find a compound compressor that is chronically inefficient, and be advised that one part after another has been repaired or replaced, until all or nearly all of the working parts have been gone over, and yet the operation is not improved. Some such cases are a matter of record, where a careful inspection showed everything in fair condition. except the high pressure air piston rings were 3/16 to 5/16 inch open, or rings in both high and low pressure air pistons 3/16 to ¼ inch open when in the smallest part of cylinder, of rings in some of the pistons of the main valve ⅛ to 3/16 inch open and a poor fit in the grooves, and when these are properly repaired the compressors work all right.

New pistons that would fit the cylinders closely at the smallest part, and in which the rings fitted the grooves with just enough clearance so they would expand by their own tension when compressed into the grooves, were applied and no other repairs made, and the compressor given a severe running test in which its capacity and speed developed were fully up to standard.

Recommended standards to cover repairing and adjustment of the different parts of compressors have been extensively published and discussed ever since the cross compound compressor came into use, but general observation would indicate that these are not taken seriously and appear to be seldom considered in connection with compressor repairs and maintenance. On account of this, the general standard of service of these compressors is considerably below what may reasonably be expected, and what may be obtained by uniformly raising the standard of quality of work done in maintaining them, which may be done at slightly increased cost, and by simply following standards such as those outlined in recommended practice by the Air Brake Association.

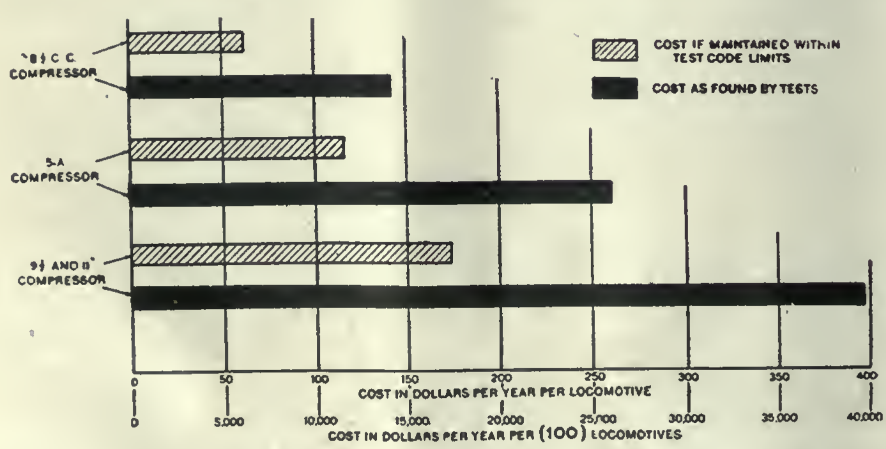
The Northwest Air Brake Club believes that it is time for a general awakening to the need of progress and improvement along these lines, and that the logical and most effective means of bringing about such improvement is through the influence of the Air Brake Association and the air brake clubs throughout the country. The number of engine failures chargeable to the air compressor alone, indicate the need for improved compressor maintenance, and the other troubles that can readily be traced directly to a lowered compressor efficiency, emphasize it emphatically.

In the course of the discussion that followed the reading of the paper opinions were expressed that some of the difficulties referred to arose from improper lubrication. When oil is admitted to the air



AIR CONSUMPTION OF AUXILIARY DEVICES ON LOCOMOTIVES DETERMINED FROM TESTS OF 111 ENGINES.

end of the compressor in amounts greater that that required for lubricating the excess finds its way into the discharge valves and past them through the operating valves and cocks, with the result that the free flow of air through the piping is seriously interfered with. This calls for greater care in lubricating the air compressor. In regard to what is known as the orifice test, the opinion was expressed that it is not sufficiently rigid to meet general requirements, particularly in mountain service. The consensus of opinion, however, was that train line and cylinder leakage should be more generally corrected, and it may be safely expected that the average pump, in fairly good condition, will have a capacity sufficient to meet the requirements of the service.



ANNUAL COST OF COMPRESSED AIR USED BY THREE AUXILIARIES AND THE PROBABLE COST UNDER PROPOSED CONDENSING LIMITS.

Terminal Tests of Air Brakes.

W. P. Borland, chief of the Bureau of Safety of the Interstate Commerce Commission, spoke at considerable length on terminal tests made by the commission's inspectors, and pointed out that there was now no longer any lack of available equipment, and any failure to comply with the law must be ascribed to neglect. In brake tests of over 40,000 cars, 330 cars were found with brakes cut out, and 1,947 with inoperative brakes. These terminal tests on departing trains do not correctly disclose actual operating conditions, for the reason that when the presence of a government inspector is known more than usual care and diligence are exercised in inspecting and testing brakes, as well as in setting out, or repairing cars with defective brake equipment. As a result, reports of such tests are misleading and indicate better conditions and practices than actually exist.

In order to obtain a check upon the true condition of air brake equipment in general, tests of trains upon their arrival at terminals have been made during the past year. In some instances the contrasts between the condition of arriving and departing trains are extreme and striking, in one yard from which trains were departing with 100 per cent. operative brakes, trains were arriving with as low as 56 per cent. operative brakes. The law does not specify the brake equipment required on trains leaving terminals only; it states that it is unlawful to run any train on its line without the specified equipment.

Inspections have also indicated the necessity that more attention be devoted to the condition of foundation brake rigging. The need of better maintenance of this equipment is particularly apparent in view of the fact that the foundation brake rigging is an essential part of both the air brake and the hand brake equipment on a car and an inoperative hand brake is a penalty defect. It is the purpose of the bureau of safety in future to devote more attention to the condition of foundation brake rigging.

In many locations tests which are intended merely to show that brakes are operative are insufficient to meet operating requirements; it is essential not only to have operative brakes, but also to make certain that the equipment is in efficient operating condition, including foundation brake rigging, brake cylinder, triple valve, retaining valve and all piping. Inoperative and inefficient brakes combined have resulted in numerous violations of the air brake law on mountain grades. There are a number of mountain grades in various parts of the country upon which it is common practice to control trains by means of hand brakes, holding the air brakes in reserve and using them only in case of necessity or emergency to supplement the hand brakes. On some of these grades no other practice has ever been followed. The attention of the commission has been called to the situations in which these unlawful practices exist at various times and for various specific reasons. In one case an accident resulting from a portion of a train running away on one of these grades was investigated by the bureau of safety, and this investigation disclosed that one of the conditions leading up to this accident was the use of hand brakes for the purpose of controlling the train. Complaints regarding the practice of using hand brakes on other grades have been received from time to time, and the bureau's inspectors have discovered similar practices on the other grades. Proper maintenance of present equipment is all that is required to permit trains to be handled safely on these grades by means of power brakes. And it is in the terminals through which these cars pass en route to these grades that the greater part of the maintenance work must be done. Excessive leakage and defective retainers were among the prevailing conditions which required considerable attention.

In the discussion that followed, a need of a stricter enforcement of the laws in regard to inspection was strongly recommended.

Location of Brake Pipe Ends at Locomotive Pilots.

The second day's session, Wednesday, May 5, was opened by the reading of a paper on the above subject by W. W. Wood, Chicago, Indianapolis & Louisville railway. This paper was submitted to the association by the Western Air Brake Club, and we reproduce the matter in its entirety:

"At the pilot of a locomotive a situation exists in which the recommended practice, as it concerns 'brake-pipe ends,' can not be successfully adhered to. The extended pilot, formerly standard everywhere, would not permit the diagonal cross-carrying of the coupled hose when connected with a car ahead or the rear of a leading locomotive, if the pipe end was on the left side of the drawbar; for that reason the pipe ends are commonly found to be the right of the drawbar (using the common distinction as to the right and left sides of a locomotive). Here is a condition that provides a brake pipe without lateral deflection from rear to front of locomotive.

"But the locomottive builders having located the pipe end twenty-six inches away from the point standardized by the M. C. B. for cars, have fixed its height from rail and the distances from center line of drawbar shank and pulling face of coupler knuckle, the same as provided for cars; this brought the terminal angle-fitting too close to the angle cock of the car ahead. Most railroad shops are following this practice.

"The result on our road before we applied the remedy, was that when the air was coupled to a car ahead both hose of the connected pair would be crimped and the passage of air restricted. An instance is found in the case of a double-headed passenger train where the air signal and brake equipment of each engine had been tested and found o. k. before leaving the roundhouse; the air piping of the second engine was exactly as it came from the builders, and pipe terminals on tender of forward engine were approximately M. C. B. standard in location; after coupling-up, both pairs of hose, brake and signal, were crimped so flat that the air signal on the leading engine could not be operated from the cars, but would respond to discharges from the pilot hose ahead; brakes on the cars would apply upon service reduction from the leading engine, but with emergency test from the leading engine, service application was obtained on the cars only.

"Recommended practice now extends the brake-pipe ends on certain classes of freight cars much nearer the line of the pulling face of coupler knuckle than formerly. Two modern, steel freight cars coupled together have their connected hose couplings carried at angle of ninety degrees to the center line of car; they couple exactly crosswise. If one of such cars were coupled to the pilot of an engine having pipe ends as usually found, we would have a condition that should be considered absolutely impossible.

"When this subject was brought up at the last meeting of the Central Air Brake Club, some members argued that with the modern, receded pilot, it would be possible to locate the brake-pipe ends at the left of the drawbar and follow the M. C. B. specifications as to location throughout, and get a good lining-up of the hose when connected with car ahead. This may hold good on some engines, on certain roads, but not on all. It introduces additional angularity or curvature of pipe equaling a total of ninety degrees. And to what effect? The reasons for adhering to the car standards do not apply to the pilot of a locomotive. On our road we have found it an easy matter to keep the pipe lines on the right of drawbar and obtain an ideal line-up of the hose when coupled forward.

"Experimentally, we coupled a locomotive to the rear of a tender having standard pipe-end locations; detached the hose and angle fitting from brake pipe at pilot and connected its coupling with that of the tender, and screwed a short piece of pipe into the other opening of the angle fitting to represent the brake pipe. Laying this piece of pipe directly on top of the pilot beam, its center thirteen inches from center line of coupler shank, we found it the ideal location. In practice we turn the angle fitting slightly toward the center of track, about twenty degrees from a vertical line through the brake pipe. No attempt was made to standardize this location until we found that it would apply to every class of engine in service on our road. This might not happen so fortunately everywhere. It is recommended that the car piping standards should be generally disregarded in the installation of pipe terminals at the pilot, and the proper locations be found at the right of the drawbar."

In the ensuing discussion that followed interesting instances in which trains were passing through snow drifts were described by a Canadian representative, in some cases the angle cocks on engine pilots had been open, resulting in stalling the trains, showing the need of improvement in the regulations regarding the location of the hose couplings. The subject will be discussed at the June convention of Section III.—Mechanical, and a special committee of members of the Air Brake Association will report further on the matter.

Air Signal Valve Maintenance.

James Elder, of the Chicago, Milwaukee & St. Paul railroad, read a paper on the above subject, which had been already endorsed by the Central Air Brake Club, the salient features of which are as follows:

From the experience of those who have investigated this subject, conclusions have been made that where air signal valves are repaired so that they will pass the tests specified, those same valves will give good service for the entire period the locomotive is out of the back shop and until its return, with the possible exception of renewing the diaphragm. Thus the expensive repeated attempts of roundhouse men to keep tinkering with air signal apparatus would be wonderfully reduced. With the exception of changing a ruptured diaphragm, no other repairs to signal valves should be attempted in roundhouses or small shops. It appears needless to say that a sufficient quantity of good repair or new signal valves should be obtained and be accessible for exchange purposes.

The important back shops should be supplied with suitable inexpensive test racks, to represent the volume and resistance of a fifteen (15) car passenger train, so that signal valve can be tested while locomotives are passing through back shops, and no signal valve should be returned to any locomotive, wherein the valve in question fails to pass the tests prescribed. This also applies to such valves sent in for repairs.

The greatest advantage will be gained by doing extensive repairs to signal valves at only the main shops. When signal valves are found worn or "butchered" out of standard, and heavy repairs are required to put them in shape, and the valves cannot be repaired so they will pass satisfactorily, it will be to the advantage of the railway to send them to the manufacturer and have them re-standardized.

Some of the troubles incident to poor operating signal valves are (a) worn fit of stem and guide bushing, (b) bearing fit of stem in bushing carelessly destroyed by inexperienced workmen, either reducing the stem bearing with a file or mashing same in a vise while holding it to remove the diaphragm, (c) removing the teat at lower end of stem by filing it away, (d) facing off the seat at the upper side of the lower cap nut, (e) the use of inflexible diaphragms other than those made especially for signal valves.

In the discussion following the reading of the paper it was brought out that the signal valve was frequently improperly located, sometimes when the heat from the boiler had a pernicious effect on the material of the valve diaphragm, and sometimes under the running board where the variable temperature had a similar effect. The back of the cab would be more suitable. The location of the strainers should also be more fully considered, their position just ahead of the valves having the effect of collecting matter that remained there, eventually shutting off the flow of air. The branch pipe tees would be more suitable, as the blasts of air flowing in different directions would prevent the lodgment of foreign matter at any particular location.

An invitation from Secretary Hawthorne, Section III.—Mechanical, was received and accepted, and the president was on motion authorized to appoint a special committee to attend the convention at Atlantic City.

Air Consumption of Locomotive Auxiliaries.

It will be recalled that at last year's convention of the association a committee of which C. H. Weaver, of the New York Central, was chairman, reported at length presenting details of a series of tests made for the purpose of determining the amounts of air used in locomotive accessories other than the air brake, including such devices as reverse gears, bell ringers, sanders, coal pushers, water scoops, fire doors and other appliances. A series of charts were shown at that time, and much interest was shown in the matter and the use of a separate compressor for the auxiliaries was suggested. Among the recommendations favorably received and adopted was that the investigations be extended by the same committee, and to this end the committee formulated a code of tests which were industriously circulated among the leading air brake men. The code classified the work to be done so that the results could be categorically tabulated. This included tests of the locomotive piping with all auxiliary devices shut off; this leakage plus the flow thrown on orifice of known diameter attached preferably to the main reservoir drain cock; and the leakage of the locomotive piping plus the air consumption of each auxiliary device separately. The rates of air consumption are recorded in strokes per minute of the compressor required to maintain 60 lbs. pressure in the main reservoir. In this way by deducting the amount of pipe leakage from the other amount of air consumption and dividing the net figure for device consumption by the net figure for flow through the orifice, this shows the number of compressor strokes needed to supply the orifice which are required to operate the device.

Fig. 1 shows the results of the standing tests made by the committee. The condemning limits proposed by the committee are expressed as a percentage of the orifice strokes in comparison with the results obtained from the tests. The average maximum and minimum values for leakage are given for each condition under which the devices were tested, on the basis of 100 lb. main reservoir pressure. The results may be taken as a reliable index of the general condition and performance of the auxiliary devices, and of which out of 497 of the devices tested, 213 passed the test, leaving 284 condemned, being considerably more than one half of the number tested.

In the running tests of reverse gears, 15 gears fitted with metallic and 6 gears with non-metallic packing were tested, and the result showed largely in favor of metallic packing. The period of time, over which the tests extended was said to be hardly sufficient to warrant final conclusions, but the data so far was much in favor of the metallic packing. The tests' results generally showed a glaring need of better maintenance of the appliances which performed their functions satisfactorily with a considerably greater sacrifice of compressed air than should be necessary if the appliances were maintained in better condition.

The result of the tests are the best guide that has so far been established tending to show how much the actual cost is to operate auxiliary devices in comparison with how much more economically they could be operated. Fig. 2 shows a graphic illustration of three of these devices as now operated compared with what they might be made to cost. These three in succession include bell ringers, fire doors and reverse gears. It is not to be expected that the losses as shown could be under any condition entirely eliminated but they could be reduced more than 50 per cent without any great effort on the part of those in charge of repairs. At present, or during the period at which the tests were made, the data furnished by the committee showed that locomotives equipped with the three devices referred to required a supply of 31.12 cubic feet of free air per minute to operate them, whereas if they were maintained and held within the test code limits they would only require 13.7 cubic feet of free air per minute. Expense estimates were added in the committee's report showing that on the basis of 100 locomotives equipped with 11-in. compressors, the cost per year without maintenance would be $39,000, and with maintenance about $17,500.

Many of the members expressed their surprise at the magnitude of the losses as shown by the committee's report, and others testified to the genuineness of the tests and the reliability of the data secured. On motion the committee was continued, and a suggestion was favorably received that the executive committee call the attention of the American Railroad Association, Section III—Mechanical, to the report of the Committee as presented to the Air Brake Association.

Relation of Terminal Brake Work to Freight Train Revenue.

C. C. Ferguson, general air brake inspector of the Great Northern, presented a paper on the above subject, which was submitted with the approval of the North Western Air Brake Club, which embodied the following recommendations:

1. Freight cars in terminal yards should have the air brakes tested as follows:

2. Freight trains, on arrival at terminals where inspectors are stationed to make immediate air brake inspection and repairs, shall have slack stretched and left with brakes fully applied in service application. Inspection of brakes should be made as soon thereafter as practicable and any needed repairs made, or promptly mark for repair tracks any cars that cannot otherwise be repaired.

3. While the train is being charged, make a visual inspection of retaining valves and retaining valve pipes, position of angle cocks and hose, and examine closely for leaks from the brake pipe and its connections, and make necessary repairs to reduce this leakage to a minimum when the brake system is charged to standard pressure.

4. When the brake is charged to standard pressure, makes a 15-lb. service reduction, after which a second examination of the train should be made to determine:

a—Brake pipe leakage.

b—If triple valve will operate on service application.

c—Piston travel.

d—Brake cylinder leakage.

e—If the brakes release properly.

5. If during this test the brake pipe leakage, as indicated by the brake pipe gage, exceeds 8 lb. per minute, it should be reduced to 8 lb., preferably 5 lb., and if piston travel is less than 6 in. or more than 8 in. it should be adjusted to 7 in. All defects found shall be repaired in the yard or car sent to shop or repair track for necessary attention.

6. In addition to the above terminal tests, at last terminal inspection point prior to descending mountain grades, it must be known that a sufficient number of retaining valves are in good operating condition to control the train.

The committee recommended that paragraph 2 of the foregoing should be changed to read as follows:

2. The incoming air brake test should be made with all arriving freight trains and transfers, and to permit of this the incoming crews shall leave the brakes fully applied from standard pressure by a service reduction or reductions totalling 20 lb. Inspection of the brakes shall be begun immediately and completed within 20 minutes, confining it to observance of piston travel, brakes that do not apply or that leak off and to other observable leakage, and quickly indicating defects found by suitable chalk marks. On completion of this inspection make indicated repairs or mark cars for the repair tracks, as the circumstances require.

This inspection is mainly to determine whether the brakes are reasonably efficient, and will be that a brake which has not leaked off in 20 minutes will meet with this requirement. To appreciably extend this inspection time is unwarrantedly to delay traffic and increase expense, as it will send cars with reasonably efficient brakes to the repair tracks. The alternative is that inefficient brakes will not be detected.

In the discussion that followed it was indicated that freight brakes are generally in an unsatisfactory condition due to a large number of causes including excessive air pipe leakage, careless and unskilled work in maintenance, inadequacy of the regular type of attachments for air brake cylinders and auxiliary reservoirs, retention in reserve of wornout brake cylinders in which tight packing leathers are an impossibility, and lack of earnestness in maintaining a high standard of efficiency. It was gratifying to learn that this was not the universal condition, the members for some of the roads testifying that the maintenance of a high degree of efficiency was not such a difficult matter if once by a united effort it could be established. The subject was referred to a special committee to present further recommendations and present data as to possible savings that could be effected by a stricter adhesion to the best available practices.

Freight Train Brake Work in Terminals from the Revenue Standpoint.

C. C. Ferguson, Great Northern, and representing the Northwestern Air Brake Club, opened the third day's session by reading a paper on the above subject in which he made several valuable suggestions in regard to the saving of time in making inspections, and from which we quote the most important recommendation as affecting the method of inspection:

"Enginemen and trainmen of freight trains on arrival at terminals will leave the brakes applied by a 20 pound service reduction made from 70 pounds. Where engineman has made an automatic application for stopping he will, as soon as stopped, add to it by one farther, continuous reduction sufficient to make a total of 20 pounds, and watching the gage, insure that this amount is had when the brake valve discharge ceases. On its completion he will give one short whistle blast as advice to brakeman that he may cut off and to inspectors that inspection may begin. The brakeman will not close angle cocks until this signal is given.

"When the train must be left on two or more tracks, or when crossings must be cut, those concerned will follow the foregoing plan before cutting off each part.

"To avoid preventing inspectors from ascertaining the condition of air brakes switchmen, carmen and others must not discharge any air from the auxiliary reservoirs or brake pipe of cars that have not been inspected. Before discharging any air from those already inspected an angle cock must be closed between such and any uninspected brakes.

"On brakes being applied, as indicated by whistle signal inspectors will at once and rapidly examine for piston travel, brakes failing to apply, any that have leaked off and brake pipe leaks. At this time, make no repairs; merely indicate the defects with chalk. After completing inspection repair the defects that should be cared for in the yard. For other defects bad-order cars for repair tracks, unless impracticable, as may be with perishable or time freight. The air brake and the general inspection must not be made by the same man or men.

"Adjust incorrect piston travel (less than six inches or over eight inches) to seven inches, but before marking for apparent short travel be sure, by trying a brake beam, that the brake has not partially leaked off. When a brake shoe can be moved easily, as with one's foot, the brake piston has leaked back one inch or more. Consider cars over 12 months since brakes were cleaned as having defective brakes. Loads that cannot be held for brake repairs earlier will, where destination is a terminal, be marked on arrival 'BO when empty,' with date, and defect. These will be delivered to repair tracks as soon as practicable after unloading."

In the discussion that ensued it was made particularly clear that it was necessary that more attention should be given to the question of air brake maintenance, and that all cars found on a given line should be treated as the property of that line, and much better results would be obtained than at present. It was also pointed out that the repairs were too frequently of a temporary kind, particularly in the make shift renewal of packing, whereas it would be easy to discover that the cylinders might be out of condition, justifying a renewal thereby avoiding the expense in attempting to correct a condition which packing leathers could not do. As a result of the discussion a recommendation was adopted to appoint a committee to report further on the subject at next year's convention.

Changes in the H-6 Valve.

A committee representing the St. Louis Air Brake Club submitted a report embodying recommendations of changes on the H-6 valve. The committee included W. H. Davies, R. E. Wark and E. B. Johnson. The report was as follows:

"The continued increase in the number of driving wheel tires overheating and loosening caused us to adopt methods of procedure which have resulted in such decided improvement that we feel our experience may be of value to others, and we enumerate the methods as follows:

"(1) The elimination of holding feature in holding position of H-6 brake valve.

"(2) The release, or partial release, of locomotive brakes during the period while brake valve handle is on lap position during a two application stop and the avoidance of high locomotive brake cylinder pressure during final portion of stop.

"(3) The adoption of the collapsible type of equalizing piston.

"(4) The rigid checking of driving brake foundation brake gear and correction, where found, of any deviation from standard.

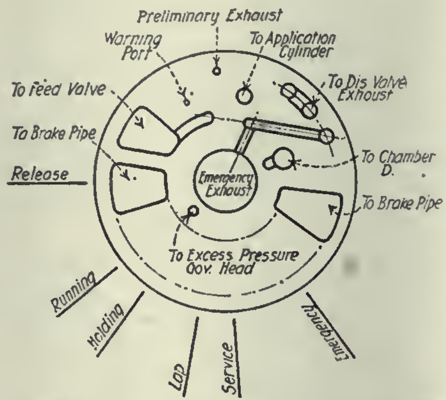
"The first three named changes are provided in new brake valves now being sent out by the air brake companies, and all that is necessary to procure the first two named is to remove the brass plugs. It was thought, however, that rotary valve seats of brake valves on locomotives in service could not be changed to produce the second named feature, due to the position of port in seat body, which leads to the equalizing chamber; this difficulty, however, was found of easy solution by drilling the horizontal port connection inward to the central exhaust cavity, instead of outward to the side of brake valve body.

"The drilling of ports in rotary seat, also the drilling of holes in rotary valve face to facilitate cutting the extra cavity, is done as indicated in the sketch, and is greatly aided by a jig which is especially devised for this purpose."

In the discussion that followed the fact was emphasized that some change in the H-6 valves is deemed necessary. As an illustration it was stated that on one of the Eastern roads the enginemen had accomplished the elimination of the holding feature of the valve by loosening the coupling nut on the release pipe, thereby allowing the pressure in the engine brake cylinders to blow down gradually through the loosened coupling. The air-brake authorities on the road took up the matter and by drilling a 1/16 in. hole in the valve seat, permitted the required leakage on all engines equipped with this device.

CLOSING ADDRESSES AND REPORTS.

During the closing exercises of the convention an interesting illustrated address was delivered by J. C. McCune, wherein he described the U C Equipment. The matter had the endorsement of the Manhattan Air Brake Club, and was warmly appreciated by the members of the Air Brake Association. Addresses were also delivered by W. H. Winterrowd, chief



MANNER OF ELIMINATING HOLDING FEATURE IN H6 BRAKE VALVE.

mechanical engineer of the Canadian Pacific, and F. W. Brazier, assistant to the general superintendent of rolling stock, New York Central. R. L. Cunningham, of the Westinghouse Air Brake Company, spoke of his experiences among the air brake men in France. The secretary called attention to a tentative set of by-laws designed to protect the interests of the members of the Association in the event of affiliation with Section III—Mechanical. The Executive Committee were instructed to report on the matter at the next annual convention. The secretary further reported that 375 members had registered as being present, and the exhibitors of air brake specialties numbered 45. The display of details of air brake devices was considered the most complete hitherto provided, and attracted much interest.

Election of Officers.

The following were elected officers for the ensuing year: President, L. P. Streeter, Illinois Central; first vice-president, Mark Purcell, Northern Pacific; second vice-president, George H. Wood, Atchison, Topeka & Santa Fe; third vice-president, B. M. Kidd, Norfolk & Western; secretary, F. M. Nellis, Westinghouse Air Brake Company; treasurer, Otto Best, Nathan Manufacturing Company; member of executive committee, W. W. White, New York Central.

The Automatic Hose Connector

An Important Advance on Present Type Hose Connections

Every man who attended the conventions of the Master Car Builders' Association in the early days will have very vivid recollections of the motley array of impossible contrivances, for coupling cars that were presented year after year, until the advent of the Janney coupler and the establishment of its contour lines as a standard. And, even since that time, the appearance of new and strange devices has not been an unknown quantity, nor has the standard been free from the infliction of a multiplicity of parts.

For the coupler there was a real demand. Men were being killed and wounded by the score every week, and the public knew of it and sentiment finally led to the adoption of an automatic coupler, the use of which should avoid the necessity of men going between the cars in order to make connections.

But for every coupling made it is still necessary that some one should go between the cars to couple the air hose, and, on pasesnger cars, the steam and signal hose as well. This is not a particularly hazardous piece of work and yet it is not without its dangers. Men do not always wait until cars are at a standstill before going between to couple the hose, and sometimes an engineer will move a train before the man has had a chance to come out, with the result that there are still killed and crippled men as a record of the fact that the automatic coupler is not so entirely automatic that no hand work need be done in the attaching of one car to its fellow. To which may be added more than occasional injuries caused by scalding due to the escaping steam or hot water from the heater hose.

But the toll of human flesh is not so great as to attract general attention when it takes a holocaust to arouse the public, so that the latter knows nothing and cares less about this phase or detail of railroad operation. And apparently the attitude of railroad officials has been one of more or less indifference on the subject. But, despite this lack of interest designers have not been idle, and for several years a number of engineers have busied themselves with the development of connectors that should automatically couple the three lines of hose essential to the operation of a passenger train. Some of these designs went so far as to include not only the functions of the connector proper, but the coupler and even the safety chains as well. In a few cases of electric railway operation such a complete connector and coupler has been in constant and satisfactory operation, while our Canadian neighbors have several hundred of the straight hose connectors in use on both passenger and freight cars.

The point that the railroad officer has to consider is the paying qualities of a good connector. Will it add to the safety of the men, the certainty of operation and be a saving of expense?

Of course the first outlay for a connector will be more than for the six pieces of hose with their couplings that are now used. But even this cost for hose and couplings would help somewhat in paying for the two connectors on a car.

The essential qualifications for a satisfactory connector are that it should be of as low first cost as possible; its weight should be at a minimum; it must be of a strong and substantial construction so as to be able to withstand the wear and tear and shocks to which it will be subjected in service, that its life may be at a maximum, and finally its operation should be the nearest possible approach to a certainty.

These are conditions which have been met, insofar as the actual physical design of the connector is concerned.

Now, of all of the essentials contributing to the success of a connector the crucial ones are cost and upkeep, the latter to include the interest on first cost as well as the actual cost of maintenance.

To offset these two items we have, first the cost of the present hose and couplings. Then in upkeep we have that of the upkeep of the present hose with its couplings. On a well designed connector the movement is so slight that the wear and tear of the flexible connections, which are usually hose, is so small as to be an almost negligible quantity. Hose are in use that were placed in position six years ago which can probably not be said of many pieces of ordinary hose placed eighteen months ago. So that the connector should be credited not only with the cost of the replacement hose but with that of applying the same.

Then there is another expense that is a sort of continuous performance in every passenger yard in the country, namely, the cost of making three hose connections every time two cars are brought together in the making up of a train. Instead of simply bringing them together and signaling the engineer to continue or reverse the motion, with no delay at all, the yardman waits until the cars are at a standstill, when he crawls beneath and, in an awkward and cramped position, does the work. The time required for this is a function of the season of the year, the state of the weather, the size of the man and the particular location of the cars.

If the man is small and alert; the season, the moderate portions of the spring or fall; the weather pleasant and the cars on a flat yard, the work can be done in a few seconds. But if the man be large and fat; the season mid winter; the weather treating the region to a northern blizzard and the cars be standing on a bridge with couplings covered with snow and ice, the time of doing the work may run into more minutes than a few.

The cost of this time should be credited wholly to the saving effected by an automatic connector. The cost of doing the work between the cars must be multiplied by the number of cars in the train. And this again by the wages of the whole train crew, and possibly by the two or more crews that may be delayed. For it must not be taken as merely the time of the one man doing the work, which may be anywhere from 20 seconds to as many minutes. To this we may add the cost of the coal burned in the engine, while so standing, if hairs are to split and a fractional accuracy to be obtained. If a time study were to be made of the work of a passenger yard crew and a determination made of the time lost waiting for men under the cars to make hose connections it would probably be a startling revelation to most operating officers. And it is more than probable that the saving of this time might mean the difference between a congested and a free yard; between a hurried and a safely working crew for hurried work in a railroad yard is always unsafe, and between a delayed train and one on time. All of which would go far towards paying the interest charges on the extra investment in connectors, compared with the present type of hose connections.

These are simply suggestions as to the points to be considered in connection with the adoption of a connector, which would probably have already been in universal use had the working at hose coupling beneath the cars been but a trifle more hazardous than it is, so as to attract attention and give the politician another chance to do something for the dear public.

As for the use of the connector on freight cars, that is another story, as Kipling would say. Their introduction so as to be effective for general work would probably require a great deal of time. But, for coal and ore roads, where the cars remain at home or are used for the most part on home trains, the use of a connector in freight yards would probably effect a great saving of time. Where trains are broken up in classification yards and have to be re-made for the next division the coupling of the hose is not only an item of considerable expense but one effecting the rapid clearing of the yard and the expediting of traffic.

Here, of course, a single line of hose only has to be taken care of, and the connector would be cheaper and lighter than for passenger service. Therefore, it would not have to save as much to meet overhead charges, and when extensively used, would be a greater money saver than its brother on a passenger car.

Therefore, when all of this is taken into consideration it would seem that it would be well worth the while of the railroads to carefully consider the use of a good connector.

Finally, this is the day of the automatic machine. It is used in all manner of places to the great saving of time and labor, as witness the automatic coupler and automatic signal, to say nothing of the yet-to-come automatic train control, all of which have contributed to our welfare. The automatic coupler has stopped short of fulfilling its whole function, and it seems as though the automatic connector were a most logical adjunct to be attached to it. Perhaps it will not pay to use it, but the indications are all the other way, but whether or no it is certainly a matter worthy of as careful consideration as others that do not present the same prospect of saving in life, limb, time and money.

The Lack of Equipment.

The continuation of car shortage in our transportation system has been very keenly felt, and while the more recent reports give assurances of improved conditions, the congestion of traffic will in all probability continue to be felt for some time to come. Many reports agree that the serious tie-up was largely caused by the recent railroad strike on the part of detached sections of discontented employees, and some of whom are still in what is considered a condition of revolt against recognized authority. But it will be remembered that previous to the strike the railroads were unable to handle the transportation of freight with the degree of celerity expected. The effort to meet the situation with depleted equipment combined with the disturbing strike produced the freight blockade felt at many points. To this also must be added the increasing demand of the traveling public for more passenger equipment, more frequent train service. The Railway Executives have carefully estimated the needs of the present time as amounting to 2,000 locomotives, 3,000 passenger cars, 100,000 freight cars, including 20,000 refrigerator cars, and 1,000 baggage cars. To this must be added replacements for the year, so that in looking ahead it is evident that there is much to do and the sooner the needed increase in rates is made the better, as the whole cost will, of course, be lighter if paid promptly, and larger if delayed by costly circumstances, and in either event the public pays the price in the end.

Brakeman's Seats on Locomotives.

On the report and recommendation of the Railway Association of Canada, it is ordered that all locomotives of railway companies subject to the board's jurisdiction be equipped with a seat for the brakeman. That the seat provided be of a comfortable design, equipped with back and window arm rest, and that such seating accommodations be provided by May 1, 1921. The original application for this innovation was made by the Brotherhood of Railroad Trainmen for the use of front end brakemen on freight trains, who are required to ride on the engine. The request had the approval of the Board's mechanical expert, concurred in by its chief operating officer, and the seats are being rapidly constructed and installed at the various division points along the road.

Superheated Steam in Yard Engines.

Bulletin No. 10, issued by the Locomotive Superheater Company, New York, contains a reissue of an illustrated article presenting in detail tests of two engines in switching service, one superheated and the other saturated. The data was carefully collected and the conclusions reliably prove the important advantages of the use of superheated steam in switching service, the average result in varying conditions calculated to make a thorough test showing a saving in fuel of over 19 per cent, and a saving of water of over 21 per cent, in favor of the switching engine equipped with superheater appliances. The article first appeared in the pages of Railway and Locomotive Engineering without any previous knowledge or co-operation on the part of the company.

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A Hopeful Outlook.

All things come to those who wait, but it is not too much to add that the hope must be kindled at the fires of a just expectation that the truth will prevail. When the history of railroad development in America shall be written there will be many dark pages recording the robberies of rebates, the paralyzing preferences, the benumbing bonuses without which the bonds could not be floated. The big bankers squeezing the carriers, and the carriers bribing the unprincipled politicians is not a pleasing picture. To this must be added the revulsion of popular feeling against crimes that could not be hid, with the result that the story of the early railroading in America with its heroic conquest of a continent, was overshadowed by ill-deserved calumny, and the work of the early pioneers looked upon as the selfish result of greedy adventurers, and a system of governmental supervision was established whose policy it seemed to be to treat the promoters as undeserving mendicants.

A change has come over the minds of our legislators. Their eyes have been partly opened by the experience gained during governmental control, and are further clarified by the resultant partial paralysis of transportation, and the need of a more liberal treatment of the railroads is now apparent to everybody. The relief is not already here, but the spirit of liberality is here and will be in operation sooner than some of us hope for. The Transportation Act of 1920 will become a landmark in continental transportation, and all we need is a little more of the exercise of that patience that never wearies, and in due time we will enjoy not only a resumption of the best system of traffic that the world has ever known, but also, as always, the cheapest. The country was never so full of men of trained ability to master every problem. The government never before gave such assurance of fair and liberal treatment, and no condition can ever arise that a united effort on the part of our people cannot overcome.

That the railroads have seen their worst days is the opinion of the best and brightest minds amongst us. That the highways of commerce will no longer be looked upon as enemies and treated as such is a foregone conclusion. Henceforth it may be safely looked for that the treatment will be sympathetic and constructive, and the lessons learned from the past are the seeds out of which will blossom the rich harvests of the days that are to be.

How It Paid

It is practically over, the strike, that is the newspapers have stopped talking about it. And now that it is over and we are settling down to recover from this disaster and gather breath to face the next one, it may be well to look to the results of what has occurred and ask the simple question as to whether it has paid. Of course it is useless to ask this question from the standpoint of the railroads. It certainly did not pay them in money. With embargoes on freight all over the country, with train schedules decimated or cancelled, with losses in perishable property, and all the attendant losses of such conditions, the money loss went to the millions, with no means in sight for recuperation or making it up. It was a total dead loss, which under the arrangement of the Government guarantee, the tax payer will have to meet; so that indirectly, at least, every man, woman and child in the country is affected.

Has it paid the strikers? From the money standpoint they are even greater sufferers than the railroads, for the men have lost their wages with no possibility of making them up, while the railroads have only lost their net income, or their income less wages, which is much less than the wages. So from a pecuniary standpoint, everybody has lost.

Probably in the way of public estimation, the railroads have been the gainers. The strikers were, from the first, regarded by the public, as well as by their old unions, as outlaws, with the result that sentiment has been against them, and, as in the case of the Kansas miners' strike, the moment there was a call for volunteers, it was instantly answered and there was no difficulty in manning any number of "indignation" specials. And, from the appearance of things, there would have been volunteers enough to take all of the strikers' places had the thing been kept up for a few days longer.

The union officials worked well with the railroads to bring their men back into line, but were not wholly successful, and while they deserve full credit for their efforts, they will not get even the credit that is their due from the public, because the latter do not think deeply, and while they know that the strikers were "outlaws," they still consider them as union men, and that, by going on the strike they have broken a solemn contract, and have thereby brought discredit on the unions. It has been a heavy body blow, this strike, for unionism, and it will take some time to recover.

The men who have really made capital out of the affair, are the red radical leaders. This and the unsuccessful steel strike have been sources of great moral revenue to them. It was pointed out in an article in the *New York Times* recently that these men preferred an unsuccessful to a successful strike. In the successful strike, the men gain their demands and go back to work as victors. They have the personal and class satisfaction of having won, and winning leads to contentment. But with an unsuccessful strike, the men are disgruntled and sullen and discontented and go to their work like galley slaves whipped to submission. They disregard the rights or wrongs of the case as a whole and are disposed to stop with the nourishment of their own wrongs, real or imaginary; and the imaginary usually outnumber and outweigh the real. They are ripe subjects for further propaganda of discontent and become the unconscious recruits for that army of revolution of which we hear so much, and constitute that real army of the disgruntled. The bitterness engendered by their losses and the unsuccessful strike, nourishes a class hatred the foundation of which lay in their own folly in listening to soft handed, glib tongued radicals who care far more for the building up of discontent than they do for laying the foundations for an upright, self-respecting and respect-inspiring industrial class. For this is what they do not want. This is the great loss of the strikers, their own self-respect.

Incidentally, of course, the more foolish and more stubborn among them will meet great losses in the sacrifice of their seniority rights on the railroads. So taken, all in all, the great outlaw strike has been a correspondingly great commercial disaster. The greatest sufferers have been, probably, the strikers themselves. Then grouped together are the public, the unions and the railroads, with the railroads probably the best off of the three, though apparently the most affected. While the only ones who can sit smugly by and rub their hands in quiet satisfaction over their work are the instigators of it all, who have reaped such a harvest of dupes, and added legions to the army of discontent.

But for the men, there is this to do. Think! Let them ask themselves, whether it is well to bring on bankruptcy and disaster for the sake of a temporary gain; and whether the preachers of riot and anarchy and revolution are the real prophets of success and comfort and prosperity, and then treat them accordingly.

The June Conventions.

It goes without saying that the railroad mechanical official who misses the June conventions of what were the Master Mechanics' and Master Car Builders' Associations misses the event of the year. It has been the growing custom of the past, accentuated by the action of the Railroad Administration of a year ago, for the managements of the railroads to order as many of their official employes as can be spared to go to Atlantic City in June and learn what they can of the doings of their fellows upon other roads, as well as to follow the example of the ancient Athenians and learn of some new thing that the supply men in their exposition may present.

There are two very good reasons why such a course should be followed this year, and it is difficult to say which should occupy the first place. So without making an invidious comparison let us take the exhibits. These have grown from year to year with a steady growth since the phenomenal leap ahead that they made in 1905, until this year every available foot of space on the great pier has been taken to the extent of more that 100,000 sq. ft. with a waiting list of would-be exhibitors who would have expanded the occupied floor area greatly beyond this had it been possible. The great value of such a display lies in the fact that what is shown is the latest development of each of the firms exhibiting. It tells the operating man of the last thing mechanical for the safeguarding and expediting of traffic, and to the mechanical man it speaks of the thousand details that enter into the economical methods of doing work and the betterment of the machinery, cars and locomotives that they have in charge. With the growth of the exposition there has come into play the practice of requiring the men sent to attend to make a report on what they have seen with recommendations as to the adoption of certain devices that may contribute to the good of the road with which they are connected. and needless to say that it is upon these recommendations that many local improvements have been made. Sometimes these men move about singly but the method by which the greatest amount of good may be absorbed seems to be that of traveling in groups of two or more and discussing things as they are presented. This serves not only to cultivate and develop the powers of observation of the individual but, by this discussion to fix matters in his mind. It is, of course, impossible for any one to see and remember it all, nor will it be possible for any paper to publish a complete review of all that can be seen at the great pier exhibit.

Then there is the second reason for attendance, the real reason for the meeting, the technical meetings. It is well within bounds to say that no associations in the world have published more valuable proceedings when considered from a purely technical standpoint, than have the Master Mechanics' and Master Car Builders' Associations, and the indications are that the future will not show any deterioration in this respect. Certainly the prospects for the coming meeting do not point in that direction.

The program for this year is comprehensive and elaborate. There are twelve standing committees and eighteen special committees to report on technical subjects besides those having to do with the routine work of the Section. The reports of the standing committees will be on:

Autogenous and Electric Welding.
Brakeshoe and Brakebeam Equipment.
Car Construction,
Car Wheels,
Couplers and Draft Gear,
Fuel Economy and Smoke Prevention,
Loading Rules,
Mechanical Stokers,
Safety Appliances,
Specifications and Tests for Materials,
Tank Cars,
Train Brake and Signal Equipment,

The special committees will report on:

Auxiliary and Safety Connections Between Engine and Tender,
Depreciation of Freight Cars,
Design, Maintenance and Operation of Electric Rolling Stock,
Design and Maintenance of Locomotive Boilers,
Engine Terminals, Design and Operation,
Establishment of Co-operative Research Bureau,
Feed Water Heaters for Locomotives,
Locomotive Headlights and Classification Lamps,
Modernization of Stationary Boiler Plants,
Prices for Labor and Materials,
Repair Shop Layouts,
Scheduling and Routing Systems for Locomotive Repair Shops,
Standard Blocking for Cradles of Car Dumping Machines,
Standard Method of Packing Journal Boxes on Freight Cars,
Superheater Locomotives,
Train Lighting and Equipment,
Train Resistance and Tonnage Rating.

Surely, this will give a technical repast that will tax the most vigorous mental digestion to the utmost, and afford food for thought for months to come.

But it is not only in the well presented reports of the committees that the value lies but in the discussion. And then underlying all this is that something that everyone expects to get, and does get in his communications with his fellows between times, and which alone usually gives more than full value for the time and money expended.

These conventions cost money, much money, probably a million dollars would not pay the cost of the one we are approaching, and all this the railroads will eventually have to pay. So that it is the part of wisdom of every road to see to it that it is well and thoroughly represented in order that it may receive full value for the outlay that is to be made and of which each will have to carry its share.

Resistance of Steel to Cutting.

At a recent meeting of the Academy of Sciences in Paris, a memorandum was presented from M. Ch. Fremont giving some interesting explanations regarding the phenomena attendant upon the cutting of metals, as follows:

For example a steel having a tensile strength of 107,000 lbs. per sq. in., when calculated according to the conventional rule universally used, that is to say by dividing the maximum stress by the original section, will wear away and dull the cutting tool quite rapidly, when another steel having a tensile strength of 166,000 lbs. per sq. in., can be easily cut and will not wear the faces of the tool. The explanation of the paradoxical phenomenon is to be found by measuring the final resistance obtained in a tensile test of the two steels.

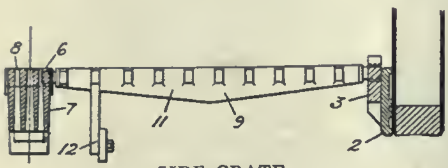
By "final resistance" is meant that which is obtained by dividing the resistance of the test piece at the moment of rupture by the actual section at the point of fracture, that is to say the reduced section of the test piece.

This final resistance or stress is less than the maximum stress which just preceeded it, but the final resistance per square inch, on the other hand, is higher than the resistance is ordinarily calculated, because the actual reduced section at the point of fracture is less than that of the original section.

Details of Parts of the Pacific Type Locomotive as Shown in Our Chart, No. 12

Grates and Ashpan.

The grates and ashpan used on the Pacific locomotive, which is the subject of our chart No. 12, are shown in detail in the accompanying engravings. The bottom of the firebox is shown by the foundation ring (1) and the two sheets, that section of the ring marked A being the rear end of the firebox. To this the ashpan support (2) is fastened, and it carries both the grates and the ashpan. At the sides a side grate support (3) is bolted. This runs the whole length of



SIDE GRATE

the firebox on each side and has a series of pockets or grate bearings (4) cast in it to carry the grate trunnions (5). As the width of the firebox is too great to be spanned by a single grate bar, there is also a center grate support (6), having two sets of bearing pockets: one for the grate on either side. This center grate support has an overall width of about 5 in. and is formed of four bars (7), each about ¾ in. wide, with an air space (8) about ½ in. wide between them, so that this forms a true grate bar running along the center line of the firebox for its whole length. As for the grate bars themselves, there are four patterns used in this single firebox. Two of them are of the finger type, one of the table or plate type and one a combination of the two.

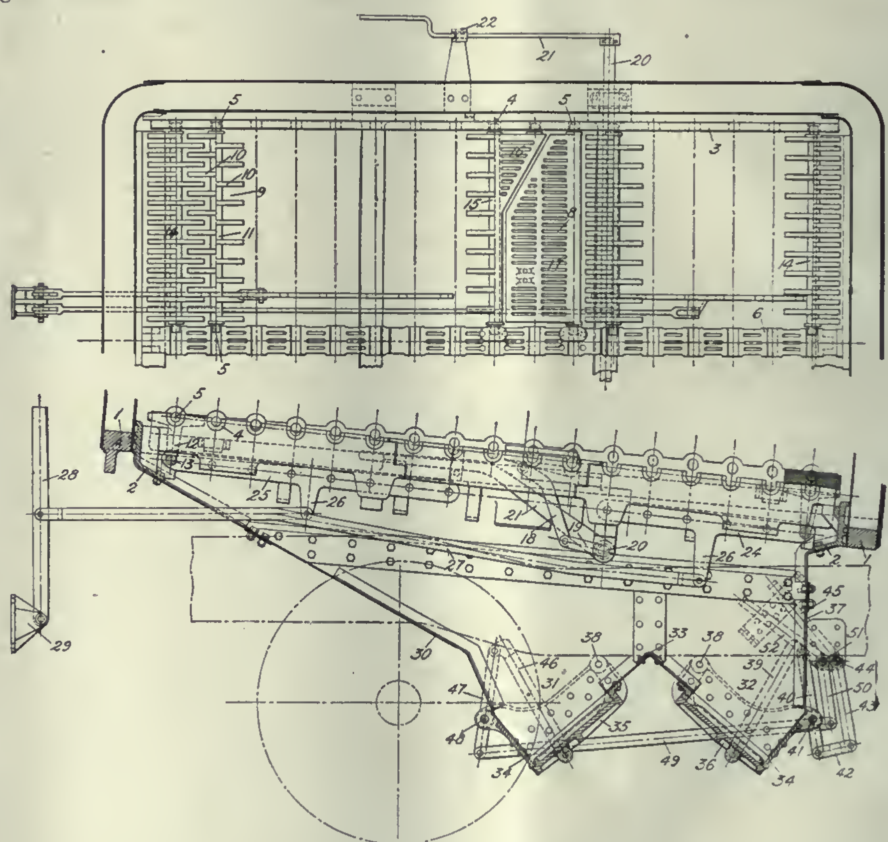
The plain finger grate bar (9) has a body (11) extending its whole length and terminating in the trunnions (5) by which it is carried. Projecting out on each side of the body are the fingers (10), which are staggered on the two sides of the body, so that as they are placed next each other they interlock, as shown at the left hand side of the engraving. Projecting down from the body is the shaking arm (12), to which the shaking bar is attached by the pin (13).

At each end of the firebox there is an end shaking grate (14). This grate is similar in construction to the finger grate (9), except that it has a double complement of fingers on one side, the one next the end of the firebox. This is done in order to keep the air spaces the same as that existing between the bodies of two adjacent finger grates (9).

At the center of the firebox there is a combination grate (15) which is carried by two trunnions at its outer end and by one at the center. This grate has fingers on one side of its body and a triangular table grate (16) at one end on the other side. The fingers mesh in with the fingers of the regular finger or shaking grate, but the whole is stationary.

The fourth grate is the drop or dump grate (17). This is a table grate that is carried by trunnions on one side and which is provided with suitable air spaces (8). When in service, this grate is held up to the level of the finger grates by a drop grate connection (18), which has one end attached to the swinging side of the drop grate and the other to the end of the drop grate shaft arm (19), which is keyed to the drop grate shaft (20). This shaft runs across the engine from side to side and is operated by the drop grate shaft lever (21). When not in use this lever rests in the drop grate shaft lever seat (22). It is evident that when the free end of this lever is moved downward, the shaft arm rotates in the same direction and, drawing the connection with it, drops the swinging end of the grate. This grate is dropped or opened for the cleaning of the fires.

For the ordinary shaking of the grates the arms of the two sections at the front and rear of the drop grate are coupled together by the shaking grate coupling bars (24 and 25). Each of these bars has a downwardly projecting shaking grate coupling bar arm (26) from the lower end of which a shaking grate connection (27) leads back to the shaking grate lever (28), which is pivoted on the shaking grate lever fulcrum (29). The lever passes up through a hole in the foot plate and is held in place by a block of iron dropped into the hole beside it. It is evident that by moving the upper end of the lever to and fro, the shaking grates will be rocked upon their trunnions and the fire shaken.



DETAILS OF GRATES AND ASHPAN

The ashpan is bolted to the lower side of the inclined flange of the ashpan support. It is made of tank steel ¼ in. thick and is riveted with ½ in. rivets. The corners are made and stiffened with 2 in. by 2 in. by ¼ in. angles. Taking the longitudinal section, the front consists of a vertical sheet, while at the rear there is the sloping bottom sheet (30). The space between the front ashpan sheet (37) and the foot of the sloping or bottom sheet is divided into a rear (31) and front hopper (32) by a hopper ridge sheet (33). The bottom of the hoppers is stiffened by the hinge plates (34). The rear (35) and front hopper doors (36) of the ashpan are hinged to the hopper hinge plates by means of the ashpan hopper door shafts (38), so that as they open they drop away from the bottom of the hopper and swing towards each other. The two doors are opened separately.

The front hopper door is held up to its closed position by the front hopper door lifting arm (39). This is pivoted to an intermediate lever (40) that is fulcrumed at (41) and whose lower end is connected to the end of ashpan hopper door operating shaft arm (43) by the lever link (42). The arm is attached to the hopper door operating shaft (44) and the latter is worked by means of operating lever (45), which is held in place by a latch. Following the movements of this combination of levers and links, it will be seen that if the upper end of the lever (45) is depressed, the arm (43) is moved to the right, carrying the lower end of the intermediate lever (40) with it. As the upper end of this lever moves to the left it lowers the lifting arm (39) and opens the front hopper door (36).

The mechanism for operating the rear hopper door is not quite so complicated. There is a lifting arm (46) attached to the lower end to the door (35), and at its upper, to the upper end of the intermediate lever, which is pivoted on the fulcrum (48) and has its lower end connected to the end of the operating arm (50) by the link (49). The operating arm is keyed to the shaft (51), which is operated by the lever (52). It will be seen that to open this rear door the upper end of the operating lever is raised.

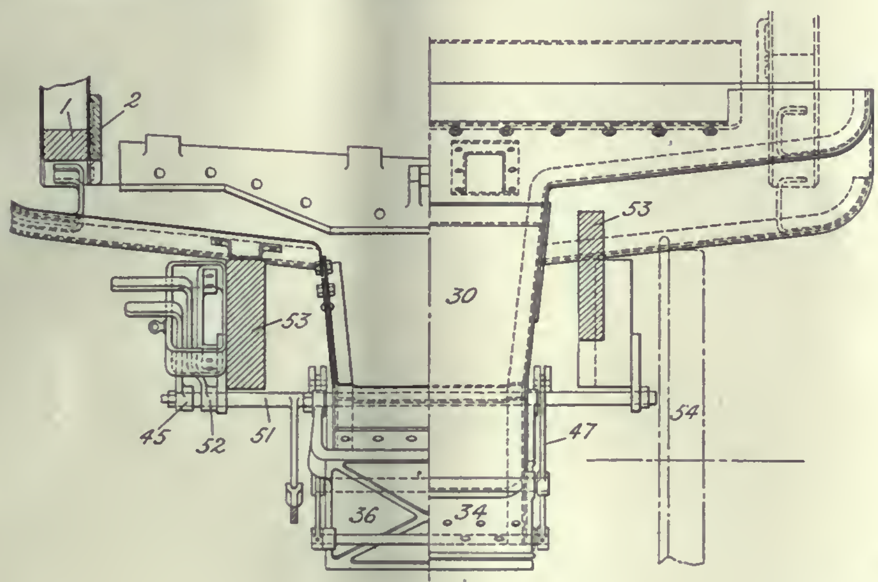
The whole of the body of the ashpan and the operating mechanism is of steel with the exception of the hopper doors and hinge plates, which are of cast iron.

The end view of the ashpan shows how it is shallow at the sides and deep at the center between the engine frames (53). The hoppers are self-cleaning and there is no need for men to go beneath the engine in order to clean the fires.

The following is a list of the reference figures to the several parts of the grates and ashpan:

List of Parts

1. Foundation ring.
2. Ashpan support.
3. Side grate support.
4. Grate bearings.
5. Grate trunnions.
6. Center grate support.
7. Center grate support bar.
8. Center grate support air space.
9. Finger grate bar.
10. Grate finger.
11. Grate body.
12. Shaking grate arm.
13. Shaking bar pin.
14. End shaking grate.
15. Combination grate.
16. Table grate.
17. Drop grate.
18. Drop grate connection.
19. Drop grate shaft arm.
20. Drop grate shaft.
21. Drop grate shaft lever.
22. Drop grate shaft lever seat.
24. Front section, shaking grate coupling bar.
25. Rear section, shaking grate coupling bar.
26. Shaking grate coupling bar arm.
27. Shaking grate connection.
28. Shaking grate lever.
29. Shaking grate lever fulcrum.
30. Ashpan bottom.
31. Rear ashpan hopper.
32. Front ashpan hopper.
33. Hopper ridge sheet.
34. Hopper hinge plate.
35. Rear hopper door of ashpan.
36. Front hopper door of ashpan.
37. Front sheet of ashpan.
38. Ashpan hopper door shaft.
39. Front ashpan hopper door lifting arm.
40. Front ashpan hopper door intermediate lever.
41. Front ashpan hopper door intermediate lever fulcrum.
42. Front ashpan hopper door lever link.
43. Front ashpan hopper door operating shaft arm.
44. Front ashpan hopper door operating shaft.
45. Front ashpan hopper door operating lever.
46. Rear ashpan hopper door lifting arm.
47. Rear ashpan hopper door intermediate lever.
48. Rear ashpan hopper door intermediate lever fulcrum.
49. Rear ashpan hopper door lever link.
50. Rear ashpan hopper door operating shaft arm.
51. Rear ashpan hopper door operating shaft.
52. Rear ashpan hopper door operating lever.
53. Engine frame.
54. Trailing engine wheel.



FURTHER DETAILS OF ASHPAN

Automatic Straight Air Brake Company

The directorate of the Automatie Straight Air Brake Company was increased from nine to eleven members at a meeting of the Board held in New York on May 12. The new directors elected were Harry B. Hunt, vice-president, and Archibald M. McCrea. A. M. Trueb was elected treasurer of the company. A very desirable location for manufacturing purposes has been obtained by the company, situated at 210 Eleventh avenue, New York City, where the necessary machine tools and other equipment are being installed, and will soon be producing brakes.

Westinghouse, Church, Kerr & Company announce their removal from 37 Wall street to 125 East 46th street, Grand Central Palace, New York City. The company's business will be conducted under the present name until the completion of the merger with Dwight P. Robinson & Co.

The Safety Car Heating and Lighting Company, with main offices at 2 Rector street, New York, announce the purchase of an additional extensive plant at Hamden, Conn., where it is expected the company will be in a position to try experimental and research work which is now being conducted to develop and manufacture other articles, in addition to their efficient lighting appliances which continue to grow in popular favor.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page* 147, *May*, 1920.)

1201. Q.—How is a safety valve adjusted?

A.—By placing the brake valve in emergency position.

1202. Q.—This will permit of what?

A.—A steady flow of air from the main reservoir into the application cylinder and the safety valve passage of the distributing valve.

1203. Q.—To what figure should it be adjusted?

A.—To 68 lbs. or between 66 and 70 lbs., for opening and closing points.

1204. Q.—If the safety valve is adjusted to 68 lbs., and the pressure increases above 70 lbs. before closing, what would be the cause?

A.—The holes leading from the spring chamber above the piston valve are restricted or the piston valve is too loose a fit in the bushing.

1205. Q.—If it opens at 68 lbs., and permits the pressure to reduce considerably below this figure before closing off?

A.—The piston valve is too neat a fit from gum or other substance, or the holes in the spring chamber are enlarged.

1206. Q.—At what times is the safety valve in communication with the application cylinder of the distributing valve?

A.—In all positions of the equalizing valve except service lap.

1207. Q.—Why not in service lap position?

A.—So that leakage past the piston valve seat would not result in a release of the brake when applied in service.

1208. Q.—What is wrong with a feed valve that overcharges the brake pipe on an engine alone when the brake valve handle is brought to running position after an application, but does not show any noticeable incorrect operation if the brake valve handle is first brought to release and then to running position?

A.—It indicates that the supply valve piston is fitted a trifle too neatly.

1209. Q.—Would it necessarily be from inaccurate workmanship?

A.—No; it might be caused by a packing of oil or dirt about the piston.

1210. Q.—Why is it that with the feed valve in this condition, the pressures equalize when the handle is brought from lap to running position?

A.—The sudden inrush of air to the feed valve tends to cock the piston in the bushing, especially if the lugs or wings at the slide valve end of the piston are a trifle too loose in the bushing, while in release position the brake pipe is supplied direct and the feed valve is not required to operate until after the brake pipe pressure has gradually reduced below the adjustment of the feed valve.

1211. Q.—Why is this?

A.—Because with a lone engine the brake valve cannot ordinarily be placed in release position without greatly overcharging the brake pipe.

1212. Q.—Should such a valve be allowed to continue in service?

A.—No, it should be removed and replaced by one that operates correctly.

1213. Q.—What might be wrong with the brake on an engine just out of the shop, if the brake pipe pressure fed up very slowly with the brake valve in running or holding position, and the feed valve would not control the brake pipe pressure and the feed valve had been repaired and tested and was known to be in good condition?

A.—It might be due to the pipe connection to the feed valve bracket having been wrongly made, or the wrong type of feed valve bracket might have been used.

1214. Q.—Why would the rate of feed up in the brake pipe be slow?

A.—Because air pressure would have to pass through the feed valve in the wrong direction and unseat the supply valve.

1215. Q.—What would govern the rate of feed up?

A.—The distance the supply valve could lift from its seat.

1216.—What would this indicate?

A.—That the newer the valve, that is, the less metal that had been removed through repairing, the slower would be the feed up.

1217. Q.—What should be done in all cases where there is any question as to the proper pressures being developed?

A.—The air gages should be known to be registering correctly before an attempt is made to remedy a disorder.

1218. Q.—Under what particular condition, as an example?

A.—In examining an air compressor on account of being reported as running slow, when the air gage shows 140 lbs. and the actual pressure in the main reservoir is between 155 and 160 lbs.

1219. Q.—How are air gages repaired and tested?

A.—It is usually done by a man in an air brake room or a tool room, and after repairs are completed the gage is tested on a dead weight testing machine.

1220. Q.—What is generally wrong with a gage that will not register correctly?

A.—There is considerable lost motion in the parts or the tube is leaking or has deteriorated.

1221. Q.—How is the condition of the tube sometimes compensated for?

A.—By changing the adjustment or travel of the hands, which can be regulated to a certain extent.

1222. Q.—Why is it that an air gage tested on a dead weight machine registers correctly but when placed on the locomotive will not register accurately with an accurate gage at the rear of the tender?

A.—It is caused by a strain on the tubes due to poor pipe fitting, especially if iron gage pipes are used, but more frequently it is due to a poor location of the gage, where high temperature affects the movement of the hands.

1223. Q.—What is it necessary to do in order to get the gage to register correctly?

A.—Remove the gage hands and replace them in accordance with the pressure shown by an accurate gage attached to the brake pipe on the tender or pilot.

1224. Q.—Is this practice recommended?

A.—No, it is generally forbidden and it is not necessary unless some abnormal conditions where a better location of gages is possible.

1225. Q.—It has been mentioned that a leaky slide valve of the quick action cylinder cap of the distributing valve and a leaky application valve both cause a blow from the exhaust port; how is the difference distinguished?

A.—By closing the stopcock in the distributing valve supply pipe; if the blow stops it indicates that the application valve is at fault.

1226. Q.—And if the blow continues?

A.—It indicates a leaky emergency slide valve.

1227. Q.—Why not positively?

A.—The supply pipe cut out cock may be leaking as well as the application valve, and in addition the leak may be from a defective reservoir gasket or through a flaw in the casting, so that the positive source of a leak cannot always be positively known on the first test.

1228. Q.—How is the leaky emergency valve sometimes distinguished from the leaky application valve without the formality of a test?

A.—By the buzzing noise sometimes made by the leaky emergency slide valve at a time when the brake is released.

1229. Q.—How can the leaky emergency valve sometimes be stopped?

A.—By lubricating the ends of the graduating spring.

1230. Q.—If this stops the blow, what is indicated?

A.—That the winding action of the spring has cocked the emergency valve stem and slide valve causing the leak.

1231. Q.—How can a leaky equalizing slide valve or graduating valve be detected without disconnecting the application cylinder and release pipes, or without making any tests with the brake valves?

A.—By applying the brake with 10 or 15 lbs. brake pipe reduction, and removing the safety valve from the distributing valve, to note any leakage into the safety valve passage.

1232. Q—Why does this positively determine slide valve leakage if it does exist?

A.—Because in this position of the distributing valve the safety valve should be positively cut off from communication with any pressure stored by these slide valves.

1232. Q.—Should the brake remain applied with the safety valve removed?

A.—Yes, if there is no leakage into this passage.

1234. Q.—How is brake cylinder leakage tested for on repaired work?

A.—By attaching an air gage to the brake cylinder and noting the fall of pressure in pounds per minute.

1235. Q.—Is brake cylinder leakage affected by the length of piston travel?

A.—Yes, if the brake cylinder is worn, rough, or uneven in different places.

1236. Q.—Is the amount of leakage existing per minute affected by different lengths of piston travel?

A.—Yes, the longer the travel, everything else being equal, the less the amount of leakage that will be shown by the air gage.

1237. Q.—For what reason?

A.—There will be a greater volume of air in the cylinder with the longest travel.

1238. Q.—If the piston travel is 8 inches, and the leakage 5 lbs. per minute, what would be the leakage due to difference in volume alone if the travel was taken up to 4 inches?

A.—Ten lbs. per minute.

1239. Q.—Why is this?

A.—With one-half the volume in the cylinder with 4 ins. piston travel, the size of opening through which air is escaping remaining the same, the rate of leakage as shown by the gage would be doubled.

(To be continued)

Train Handling.

(Continued from page 147, May, 1920.)

1245. Q.—Why is one slide valve and graduating valve used to admit air pressure to the brake cylinder and another slide valve to exhaust it?

A.—To avoid the use of excessively large slide valves.

1246. Q.—In what manner?

A.—This valve may be used to operate two 18-in. brake cylinders, and the larger the port opening the larger the slide valves must be to contain the ports.

1247. Q.—Will the 1½-lb. increase in brake pipe pressure result in a release of the brake?

A.—Yes, if the valve is in a reasonable state of efficiency and the graduated release cap is in direct release position.

1248. Q.—How is the valve changed from direct to graduated release?

A.—By turning the release piston cylinder cover in accordance with the lettering on the cap and body of the valve.

1249. Q.—What principal changes are made when the cap is turned from direct to graduated release?

A.—Emergency or quick recharge reservoir pressure is admitted to the graduated release piston chamber instead of auxiliary reservoir pressure and a suitable port opening is made from the large reservoir into the auxiliary, when the equalizing slide valve starts toward release position.

1250. Q.—And when the equalizing piston and slide valve then start toward release position as a result of a small increase in brake pipe pressure?

A.—The graduated release piston having moved from emergency reservoir pressure behind it stops the equalizing piston and slide valve in graduated release position.

1251. Q.—And there is a flow of air from where?

A.—From the emergency reservoir into the auxiliary, increasing it a trifle above the brake pipe, moving the equalizing portion to graduated release lap, reversing the movement of the release piston and slide valve, retaining air pressure in the brake cylinder.

1252. Q.—After a full service brake application, how many graduations can be made before the brake cylinder pressure is fully exhausted?

A.—From 5 to 6.

1253. Q.—What occurs if the brake-pipe pressure is promptly increased up to the adjustment of the brake pipe feed valve?

A.—The brake releases completely, regardless of the position of the graduated release cap.

1254. Q.—What makes this valve so positive to release?

A.—As soon as the equalizing slide valve can be moved toward release position, the auxiliary reservoir is opened to the atmosphere through the release slide valve to the atmosphere, which actually bleeds the brake off as positively as opening the auxiliary reservoir drain cock when a triple valve is used.

1255. Q.—What difference is there in charging the service reservoir with the release cap in the two different positions?

A.—In graduated release the service reservoir cannot be charged until the auxiliary reservoir pressure is within 5 lbs. of that in the large emergency or quick recharge reservoir, in direct release it is charged right along with the auxiliary reservoir.

1256. Q.—For what particular reason?

A.—In the first case, emergency reservoir pressure, undisturbed by the service operation, is effective on top of the charging valve, and in the second case the position of the graduated release cap provides for service reservoir pressure on top of the charging valve.

1257. Q.—Why is the large emergency reservoir pressure "undisturbed"?

A.—The emergency reservoir pressure is not used during service operation, except as pointed out for graduated release, and in this event there is but a very slight drop in emergency reservoir pressure from the momentary flow into the relatively small auxiliary.

1258. Q.—How is the locomotive brake valve handled to produce this graduation of release from the car brake cylinders?

A.—From lap to release for the first graduation and back to lap, and subsequent graduations from lap to running position and back to lap.

1259. Q.—Why is the service reservoir prevented from promptly recharging during a graduation of release?

A.—So that there will be no drain whatever on the brake pipe during a release of brakes.

1260. Q.—How is the auxiliary recharged at such times?

A.—From the inflow from the large emergency or quick recharge reservoir.

1261. Q.—What is gained by preventing a drain on the brake pipe?

A.—Stuck brakes, through the reservoirs absorbing brake pipe pressure.

1262. Q.—What is the duty of the intercepting valve?

A.—To promptly equalize the service reservoir and brake cylinder pressures in emergency position, and when this has been done, cut off the service and auxiliary reservoir pressure from the brake cylinder and admit emergency reservoir pressure into the brake cylinder.

1263. Q.—The duty of the high pressure valve?

A.—To act as a pilot valve for the intercepting valve, and move the cut-off valve, with pressure flowing to the brake cylinder.

1264. Q.—And the cut-off valve?

A.—Closes communication between the brake cylinder and safety valve.

1265. Q.—And the quick action valve?

A.—To open the brake pipe to the atmosphere.

1266. Q.—What is the movement of the emergency piston when the brake pipe rate of reduction exceeds the rate at which quick action and quick action closing chamber pressures can escape, or if the brakepipe pressure falls below the tension of the protection valve spring?

A.—The emergency piston travels its full stroke, bringing the emergency slide valve and graduating valve to emergency position.

1267. Q.—What spring is thereby compressed?

A.—The emergency piston graduating spring.

1268. Q.—What results from the emergengy slide valve movement?

A.—The emergency slide valve opens the back of the intercepting valve and high pressure valve to the atmosphere through the emergency slide valve exhaust port.

1269. Q.—Through what other slide valve does this pressure pass before escaping from the emergency slide valve exhaust port?

A.—Through a cavity in the release slide valve, it having been moved to application position as a result of the brake pipe reduction moving the equalizing portion also.

1270. Q.—Is the equalizing slide valve movement the same in service as emergency?

A.—Practically so, the same port openings are made in either operation.

1271. Q.—How long does the high pressure valve remain unseated after an emergency application?

A.—Until the brake pipe pressure is restored for a release of brakes.

1272. Q.—Can the brakes be graduated off after an emergency application?

A.—No; there would be no occasion for any graduation after an emergency application.

1273. Q.—What is the difference between an electric and a pneumatic service application?

A.—In pneumatic service, brake pipe pressure escaped at the service port of the automatic brake valve in the usual manner, while with electric service brake pipe pressure escapes into the brake cylinder, at a service rate at every universal valve in the train.

(To be continued)

Car Brake Inspection.

(Continued from page 148, May, 1920.)

1170. Q.—How is charging valve leakage then determined?

A.—By moving the brake valve handle to release position and immediately back to lap; under this condition leakage from the emergency reservoir past the small end of the charging valve will show on the service reservoir gage and must not exceed 3 lbs. in 20 seconds.

1171. Q.—And the auxiliary reservoir increase at this time?

A.—Must not increase over 1 lb. in pressure.

1172. Q.—How is the intercepting valve test made?

1172. A.—By closing the brake pipe stop cock and opening the brake pipe bleeder cock, applying the universal valve in emergency.

1173. Q.—What is to be observed?

A.—That the valve does apply in quick action and brake cylinder pressure builds up to 60 lbs. in not more than 2 seconds and reaches the required figure 65 lbs. if the small emergency reservoir is in use, or approximately 74 lbs. if the large emergency reservoir is used for emergency brake cylinder pressure.

1174. Q.—Failure to accumulate the required pressure in the brake cylinder?

A.—Indicates too strong an intercepting valve spring, excessive leakage past the intercepting valve or slip bushing or a restriction in the emergency valve port.

1175. Q.—What is to be observed in connection with draining the pressure from the quick action closing chamber at this time?

A.—That it drops from 80 to 10 lbs. in not more than 10 seconds' time.

1176. Q.—How is the service port check valve tested for leakage at this time?

A.—By closing the service and auxiliary reservoir stop cocks, the increase on the auxiliary reservoir gage must not exceed 1 lb. in 30 seconds.

1177. Q.—How is the equalizing piston packing ring tested?

A.—By removing the charging valve body and applying a special resistance cap, having all reservoirs drained or stop cocks leading to them closed and admitting air to the brake pipe through the brake valve with the feed valve or valve "J" in position No. 2.

1178. Q.—What brake pipe pressure should be shown in one minute if the packing ring is in first-class condition?

A.—Approximately 7 lbs. for a new valve, or about 4 lbs. for a cleaned valve before the ring is condemned.

1179. Q.—What if the required number of pounds pressure is not accumulated?

A.—It indicates that this pressure is passing the packing ring, and it is unfit for service if 4 lbs. cannot be obtained in one minute.

1180. Q.—What is of particular importance at such a time?

A.—To know that the restricted port in valve "J" is of the proper size and clean, and that there is no brake pipe leakage in the test rack that would interfere with this or other tests.

1181. Q.—How is the application or service sensitiveness test made?

A.—By replacing the charging valve body and recharging all reservoirs, brake pipe pressure on top of the diaphragm of the differential valve and auxiliary reservoir pressure under the diaphragm.

1182. Q.—The lever of the differential valve should be?

A.—In position No. 1, or with one weight suspended from the diaphragm.

1183. Q.—What should now occur when the brake valve handle is placed in the fifth position?

A.—A blow should start at the differential valve exhaust port when 1½ lbs. differential is obtained between the brake pipe and auxiliary reservoir pressure.

1184. Q.—Or, in other words?

A.—The rate of reduction with the brake valve in position No. 5 should exceed the back-flow through the feed groove of the equalizing piston bushing and result in a movement of the piston and graduating valve.

1185. Q.—And the discharge from the vent part at this time?

A.—Is caused by the slide valve resistance from opening the resitance increasing cavities to the atmosphere.

1186. Q.—And when the vent port opens?

A.—The differential valve handle should be placed on lap, and the brake valve handle moved back to position No. 4.

1187. Q.—And this slower rate of brake pipe reduction should cause?

A.—The universal valve to move to service application when the proper differential is obtained.

1188. Q.—About what is the total difference?

A.—Between 4 and 5 lbs.

1889. Q.—And if the valve fails to apply?

A.—It indicates packing ring leakage that was not properly developed during the ring leakage test.

1190. Q.—And the release test?

A.—Is made as with the triple valve, brake pipe pressure being increased at the required rate must move the valve to release position without causing a blow at the differential valve exhaust port.

1191. Q.—How is the graduated release test made?

A.—After changing the graduated release cap to graduated release position, a 25-lb. brake pipe reduction should be made and the pressure graduated out of the brake cylinder by alternate movements of the brake valve between lap and release position.

1192. Q.—How many graduations may be obtained if all parts are in good condition?

A.—At least 6.

1193. Q.—And if not over 4 can be obtained?

A.—It indicates a restriction in the flow of air from the large emergency reservoir into the auxiliary or excessive friction in the release piston and slide valve section.

1194. Q.—The charging valve sensitiveness test?

A.—After the last graduation auxiliary reservoir pressure should be noted and the valve handle left in release position, the charging valve should open and start to charge the service reservoir when the auxiliary reservoir pressure reaches about 77 lbs.

1195. Q.—And a failure to do so?

A.—Indicates friction in the charging valve or excessive packing ring leakage in the charging valve.

1196. Q.—How is the sensitiveness to emergency test made?

A.—By then releasing the brake and recharging the reservoirs, placing the brake valve handle on lap and opening the brake pipe exhaust cock with the larger of the two discs.

1197. Q.—What should be noted in addition to observing that this results in a quick action or emergency application?

A.—That the rate of drop in brake pipe pressure is from 70 to 50 lbs. in 2 seconds.

1198. Q.—Failure to operate in quick action indicates?

A.—An enlarged emergency slide valve exhaust port, excessive friction in the emergency portion, emergency piston spring too strong or excessive emergency piston packing ring leakage.

1199. Q.—The blanking flange being used to replace the electric portion on the bracket, what tests should be made to know that the electric ports are open?

A.—The right-hand drain cock in this blanking flange should be opened to know that the service magnet port is open.

1200. Q.—And the emergency magnet and emergency switch piston ports?

A.—The brake pipe cut-out cock must be closed, and the left-hand or switch piston port opened, then the middle or emergency magnet port should be opened.

1201. Q.—And opening the cock in the emergency magnet port should result in?

A.—Quick action operation of the universal valve accompanied from a blow from the switch piston port.

1202. Q.—The valve having passed all tests, what must be done before removing it from the test rack?

A.—The graduated release cap must be turned to direct release position.

1203. Q.—What is the object sought in operating the universal valves with electric current?

A.—To procure a rapid simultaneous application and a uniform graduated release of brakes.

1204. Q.—Which produces?

A.—A smooth stop and a perfect release of brakes.

1205. Q.—In what way?

A.—By avoiding the objectionable slack action between cars.

1206. Q.—With a train of electro pneumatic brakes, what connections are added between cars?

A.—A 7-point jumper connection between all cars and one between the tender and first car.

1207. Q.—What does this connection or cable contain?

A.—Seven copper wires for conducting the electric current.

1208. Q.—What are the names of these wires?

A.—Battery plus, battery minus, release wire, application wire, emergency wire, emergency switch wire and signal wire.

1209. Q.—Where do the wires lead to?

A.—From the jumper connections throughout the length of the engine and train.

1210. Q.—Why is there a jumper connection on the pilot of the locomotive?

A.—In case of engines double heading, when a connection is placed between the engines.

1211. Q.—At what points do the wires branch off?

A.—To the cab of the locomotive and to each universal valve in the train.

1212. Q.—Are there any other branches off this main cable line on the cars?

A.—Yes; to each car lighting battery box, and to the train signal switch.

1213. Q.—What is the object of this signal wire?

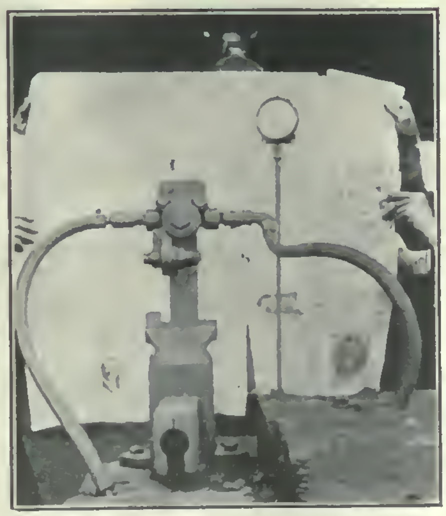
A.—To use an electric pneumatic communicating signal.

(To be continued)

Valve Test Rack, and Device for Grinding Governor Packing Rings.

By Geo. C. McDougal, Foreman Air Brake Department, Atlantic Coast Line Shops, Lakeland, Fla.

The first illustration shows a disappearing Feed Valve Test Rack for testing



DISAPPEARING FEED VALVE TEST RACK FOR TESTING WESTINGHOUSE FEED VALVES.

Westinghouse Feed valves, El Pop valves and high speed reducing valves. This tool is constructed by using an H-pipe bracket piece, No. 18463 Westinghouse catalogue 3209-1; a piece of flat iron ½ in. in thickness, 4 ins. wide, and 15 ins. long, to which the pipe bracket may be bolted; with one 12 by 33 auxiliary reservoir used for main reservoir pressure; one 10 by 24 brake pipe pressure and two short pieces of ½ in. air hose. This device may be set anywhere in very limited space in the Air room.

The second illustration, shown on a chair, is made of a few ½ in. pipe nipples and pipe tees, and operated by a Westinghouse type F nozzle valve piece No.

TESTING AND GRINDING RACK FOR PISTON PACKING RINGS.

25997. After the governor cylinder has been reamed and a new piston ring fitted to piston groove and cylinder it is customary to wear or grind the piston packing ring into the cylinder. This can be done by applying United States metal polish to the walls of the cylinder, putting the appliances together, using only one nut on the end of the steam valve. As it must be taken apart after having been ground and thoroughly cleaned and blown out, ten or a dozen cylinders may be reamed with a Perfection adjustable hand reamer, then by placing three cylinders on this testing and grinding rack, three may be ground at a time in from five to eight minutes. If necessary a dozen cylinders can be done at one time by simply increasing the number of attachments on the machine. The escape of air at the vent port shows when the piston ring is tight.

Both devices have been found very serviceable at our shops where the capacity of the Air room is limited, being about 11½ ft. by 20 ft. for both Air and Tool room.

The Page Steel & Wire Company announce a consolidation with the American Chain Company, and have removed to more commodious headquarters of the latter company in Suite 1054, Grand Central Terminal, New York City.

Snap Shots—By the Wanderer

And the Government Bossed the Job

In the olden days of private ownership appropriations for improvements were, sometimes, hard to get, frequently if not mostly impossible. So, when the shop superintendent or foreman thought of some device to save time or labor and expense, he frequently failed to ask for an appropriation, but dug out an old cylinder here, a bar of iron there and an odd piece of other junk here, there or anywhere, and did some work on it, which work was charged to repairs or engine No. — and a new and efficient machine, for doing some old job better than it had ever been done before, appeared; no questions were asked, and the railroad was richer because of the conversion of a lot of scrap into something useful, and on some item the expense of maintenance was cut down. Of course there were failures and then nothing materialized, and the company only had its scrap. But, in the long run, these attempts at betterment were more than successful, and it was the wont of general managers and superintendents not only to wink at these *sub rosa* performances but to actually encourage them, and why not?

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But when the government took control, the men who thought and did these naughty things were brought up with a round turn. They were taught from president and general manager down, never to do anything until it had been sanctioned by the man above. So if Tom Jones conceived the idea that he could take an old and scrapped brake cylinder, and by getting a new packing and adding a bar or two of scrap and a half dozen or so of bolts and pins, he could make a hoist or air clamp or any other handy tool, he couldn't go ahead and do it but must first make a requisition for an appropriation, which involved an estimate of cost, which, the whole thing being an intangible product of the imagination, would be some trouble to Jones. But if he did it and needed five bolts and the requisition called for four, then straightway Jones found himself in trouble. He mustn't over estimate or he won't get the appropriation, and he mustn't under estimate it or he will be called on to explain, and what is worse, explain to the satisfaction of a man who knows nothing of what he was trying to do. And if you have ever tried to explain to an ignorant man you know what this means and involves. So after Jones has had two or three experiences of this kind he ceases to think of new schemes and concentrates his thoughts on doing what he is told to do and holding his job. So a change of bookkeeping methods and the placing of an accountant in practical charge of engineering matters has killed many a valuable shop kink. Surely as we follow the ramifications of government control and government accounting in the details of its effects, the reason for the negative efficiency of the man here, there and everywhere is easily explicable.

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To point our moral and adorn our tale here is a sample. An appropriation had been asked for the erection of some screens required by the regulations. The specifications were sent in in some detail and the work was done. Then the government inspector came to see that the work had been properly done. Of course as the specification called for a definite number of bolts, it devolved upon him to count those used to check. Oh, horrors! There were at least six more ¼ in. by 1½ in. bolts in the screens than the specifications called for. Where did they come from? Why were they used? So a rather snappy correspondence was started, and it consumed the time of chiefs and understrappers to a goodly extent, and all to get it in to the archives why a few cents were squandered. But the man above knew that he had a record even though it cost fifty times the value of the thing it recorded. But it was good book-keeping, even though it did strain at a gnat and swallow a camel.

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Government employes like their jobs because they are not hurried, even though they may be watched, as I indicated a short time ago in telling of the man who presumed to attend a meeting to which he had not been assigned. Here is another. The X. Y. Z. railway had been authorized to build a pump house, and let us say, a section house, or something of that sort, and they were located about a hundred yards apart. The work was done and the accounts closed. They were between 400 and 500 miles from Washington or thereabouts. They were too far to be seen from the national capital even from the top of the big monument down by the Potomac. There was the rotundity of the earth and the haziness of the atmosphere that prevented. So a man was sent on a special mission to find out that the things were really as reported. He came. He said, "Where is that pump house?" "There," said the minion addressed. "Oh, oh, that is a pumphouse, is it? Behold, I photograph it." He pressed the button, the camera winked and the man felt relieved. "Now where is the section house?"

"There," said the minion, without moving from his tracks, and pointing it out.

"I'll come and take it to-morrow," said the man from W.

One photograph a day was enough for him. So on the morrow he finished his job and took back the visual evidence that the railroad had really erected the two buildings for which appropriations had been made.

It is a beautiful system this but a little expensive and such details, when multiplied galore, serve to give some idea as to the why of the railroad deficits.

Surely personal efficiency is not raised by serving the government.

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But really the fear of doing something for which the other man is paid would be funny if it were not so serious. The story of the farmer who threw a switch in and out morning and evening to start and stop a motor pump being classed as an electrician in Washington has gone the rounds. Here is a mate to it.

It has never, heretofore, been regarded as a job requiring much skill or artistic ability that of daubing the smoke-box of a locomotive with dope. But it seems that it does. The laborer or wiper or sweeper or whoever he may be who is handed a dope can and what may have been a brush in the dim and indefinite past, is straightway transformed from what he was to a painter and is entitled to all the privileges and emoluments of the same. And now the shop superintendent is confronted with a three-horned dilemma, and goodness knows a dilemma of two horns is bad enough. Shall he put a real sure-enough painter on the job? Shall he reclassify the wielder of the what-was-a-brush and mark him down a painter on the payroll? As Dogberry was marked down an ass, though in this case Dogberry's epithet might be more appropriate to the marker than to the markee. Or shall he let the smoke-box go undoped? Because the cost is more than the added beauty or preservative value is worth. Our janitor has become euphemistically speaking, a superintendent, and now if the smoke-box dauber is a painter, what can we call the painter? And if the man who daubs the front end and performs a service as valuable to the community as he who letters the cab and tender, as was claimed in the case cited, what inducement can you offer a man to do lettering? But the public pays the freight. And there again it looks as though the unions had stolen the words from a well known railroad man, that echoed around the world when he said: "The public be——" but oh, I mustn't use swear words in a technical paper.

An Old Lancaster Locomotive

BY C. H. CARUTHERS

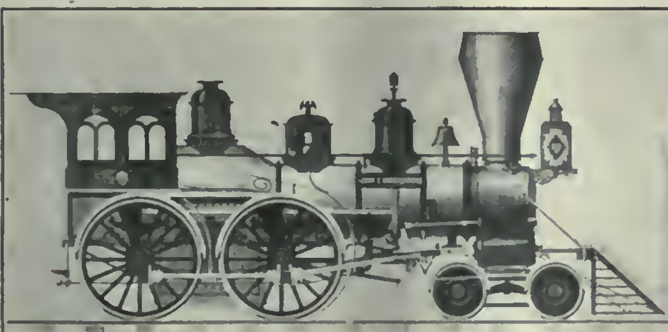
Through the courtesy of J. Howard Patton, Greensburg, Pa., there has come into my possession a photograph of a colored lithograph issued by the Lancaster Locomotive Works in 1857, showing engine "John C. Breckenridge," built by that company in the year referred to, for the Philadelphia & Columbia Railroad, then owned by the State of Pennsylvania.

This locomotive, as shown in the accompanying illustrations, was of the eight wheel, 4-4-0 type, built for passenger service. It was gorgeously painted in varied and brilliant colors, the truck and tender wheels in vermillion, the two domes, like the pillars of Solomon's temple, glittered in burnished brass; the cylinders, steam chests and sand box being also jacketed with that material, which likewise blossomed into corrugated bands at intervals over the boiler jacket. And, as if this was not enough, brilliant brass plates bearing the builder's badge covered the ends of the axles on both drivers and truck wheels. The wheel covers also were adorned in the same resplendent lustre. It was really too fine to be submitted to the open air, but whether by the exercise of watchful waiting, or perpetual polishing, engines garnished in this way ran in their bewitching brilliance for five or six years, to the apparent delight of the bewildered beholders.

The "Breckenridge" had 66 in. drives, cylinders 16 in. by 22 in., and weighed 61,000 lbs., of which 36,500 lbs. was on the drivers. The valve gear was of the Stephenson, or shifting link type. The peculiar slope of the steam chests, both longitudinally and laterally, will be observed. This feature was characteristic of all of the Lancaster, or Brandt, locomotives, and was also used on four of the engines built under Mr. Brandt's supervision for the Philadelphia & Columbia Railroad.

The records show that the engine "Breckenbridge" was placed in service in February, 1857. In August of the same year the canals, railways and equipment belonging to the State of Pennsylvania were sold to the Pennsylvania Railroad Company. The new owners soon afterwards removed the name from the locomotive and substituted the company's own consecutive number according to the date of building each engine. This engine was thereafter known as No. 195 and continued in regular passenger service until late in 1879, when it was retired.

It will be seen by comparison with the view of the second illustration that some changes were made on the engine by the new owners. This was in 1866. Among these were the removal of the forward dome. The engine was also adapted to the use of coal instead of wood as fuel. The smoke stack of the Laird type served for several years, and about 1870 the stack was replaced with a straight "Smith" stack with standard flared cap of that period, and was allowed to remain during the remainder of the existence of the engine's industrial career. This type of engine is said to have done excellent service, particularly during the Civil War period, and the writer can recall being drawn by this engine to Philadelphia in an accommodation train to the Centennial Exhibition in 1876 at a speed that would compare favorably with the modern high-powered locomotives.



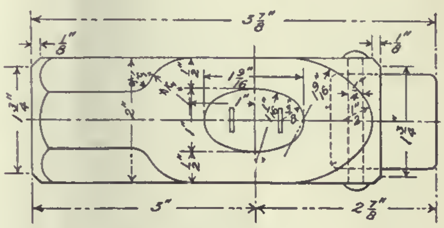
PASSENGER LOCOMOTIVE BUILT AT THE LANCASTER, PA., LOCOMOTIVE WORKS, 1857

LANCASTER LOCOMOTIVE REBUILT BY THE PENNSYLVANIA RAILROAD COMPANY, 1866

Combination Hard and Soft Hammer.

By A. C. Clarke, Pittsburgh, Pa.

It will be readily appreciated that a hammer having a hard as well as a soft metal face is a growing necessity to all who work on various machines, locomotives, and other mechanical appliances. The accompanying drawing shows the details of the top view of a simple device that meets the requirements in an eminent degree. The main part of the hammer is a steel casting of size and shape as shown, one end being cored out 1½ ins. in diameter and ¾ in. deep into which a rolled copper plug of that diameter is placed. A hole ¼ in. in diameter is drilled through the collar and copper plug, and ¼ in. pin driven in and riveted over. Iron wedges, as generally used, are driven in to spread the handle in the eye of the hammer. The replacing of a new copper plug after the inevitable wear of the soft metal need not be described. A hammer combining these features will be found not



DETAILS OF COMBINATION HARD AND SOFT HAMMER.

only to be a time saver, but its proper use at the proper time and place will leave fewer traces of the unseemly blows of circumstances that deface many of the polished parts that should be preserved in their original finish.

Westinghouse Equipment for South American Railway Electrification.

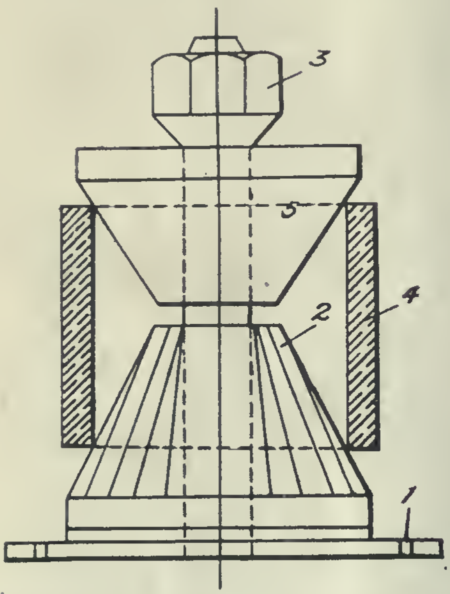
For the Paulista Railway electrification in Brazil, the Westinghouse Electric International Company announces the obtaining of contracts for four locomotives—two for passenger service and two for freight service. This electrification will initially be 28 miles in length, but later it is expected to make extensions which will include a distance of 100 miles.

The passenger locomotives have a one-hour rating of 2,000 H.P. and weigh 121 tons. They will be operated from a 3,000 volt, D.C. overhead trolley system and will be complete with regenerative control. They are designed for a maximum speed of 65 miles per hour and have a track gauge of 5 ft. 3 in. The freight locomotives have a one hour rating of 1,500 H.P. and will weigh 87 tons. They are also operated from a 3,000 volt, D.C. overhead trolley system and will be complete with regenerative control. The maximum speed will be 40 miles per hour and the gauge 5 ft. 3 in.

Some Examples of Shop Practice on the Delaware & Hudson

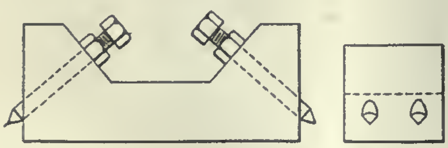
At the Watervliet shops of the Delaware & Hudson Co. the men in charge of work have developed a number of devices for expediting work and for the better utilization of present facilities.

One such utilization is the adaptation of an ordinary drill press for boring out the ends of side rods. The rods are forged with the usual solid stub end. These stub ends are first milled off on the sides to the proper thickness and finish. The centers are then laid out and a 2 in. hole bored with a radial drill. They are then taken to an ordinary drill where the work is completed. This drill has a bushing fitted in the center of its table



SPECIAL CHUCK FOR TURNING OF SIDE RODS

to serve as a bearing for the lower end of a boring bar that is driven by the drill spindle. This boring bar is made to carry double ended solid cutters, which are put through the stub end in succession until the hole is brought to the proper size for the reception of the side rod bushing. It has been found that the drill will drive a cutter that enlarges the

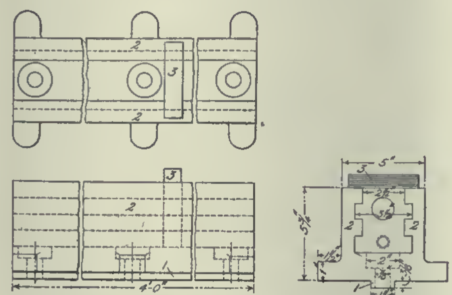


PLANER CHUCK FOR GUIDES.

hole by about ½ in. in diameter at each cut.

After the hole has been bored the bushings are pressed into place and then are themselves bored to the proper diameter for the crank pins.

The bushings are turned for pressing into the stub ends of a side rod on a small boring machine. For this a special chuck has been devised, as shown in the illustration. It consists of a base (1)



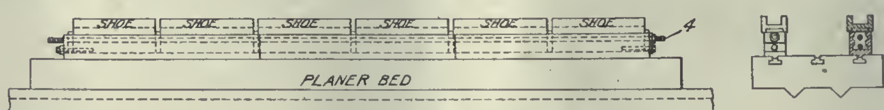
PLANER CHUCK FOR SHOES AND WEDGES

which is bolted in a central position to the table. This base carries a conical chuck piece (2). It is grooved so as to afford a better grip on the pieces that are to be turned and also has a 1¾-in. bolt (3) passing through it and projecting at the top. The bushing (4) is set down over this conical chuck and the mate (5) is dropped down over the top, and is screwed tightly into the bushing by the nut on the bolt. This centers the rough bushing and holds it securely while it is being turned.

There are quite a number of attachments for holding work on the planer. Among them is a chuck for holding guides. It is based upon the old principle of holding the piece to be planed by the points of some set screws that have a downward inclination. In this case the application only is new. The clamps or chucks are of about the size and shape shown in the illustration. Each block has approximately the same width as the guide it is intended to hold, and is fitted with two seats of holding bolts.

In setting up a machine a number of these are bolted in two lines along the bed of the planer, and so set that a guide can be conveniently dropped in between them. Two rows of guides are thus put in at once, and the holding screws are driven home. These force the guides down against the bed and hold them firmly in place. The work is done on a double-headed planer, and, as the chuck castings are a little narrower and lower than the guides, three sides of the latter can be finished without removal.

The first cuts taken are upon the two sides of one row of guides. One of the tool heads is used upon each side, so that the pressures of the tools balance each other and thus obviate any tendency to slip sideways of the guide. When the sides of both rows have been planed then the tops are finished, one head being used on each row of guides at the same time.

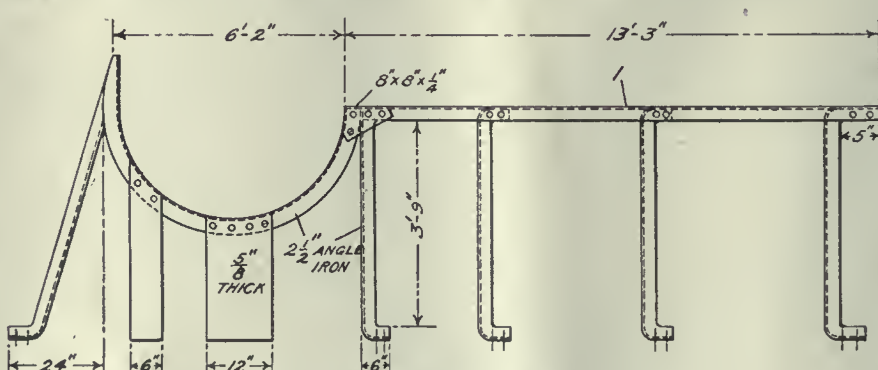


PLANER CHUCK FOR SHOES AND WEDGES

This makes it possible to use both heads and work the machine to full capacity at all times.

Another planer chuck is one used for planing driver box shoes and wedges.

It consists of three bodies each about 4 ft. long, three of which are bolted together on a planer bed, making a total length of 12 ft. and capable of taking in six shoes at once. The body has a lug (1) which fits in the groove in the platen of the planer, and to which is bolted by the usual T bolts. This body consists of two ribs (2) which are finished and grooved on their top and inner surfaces to take a series of dogs (3) which can

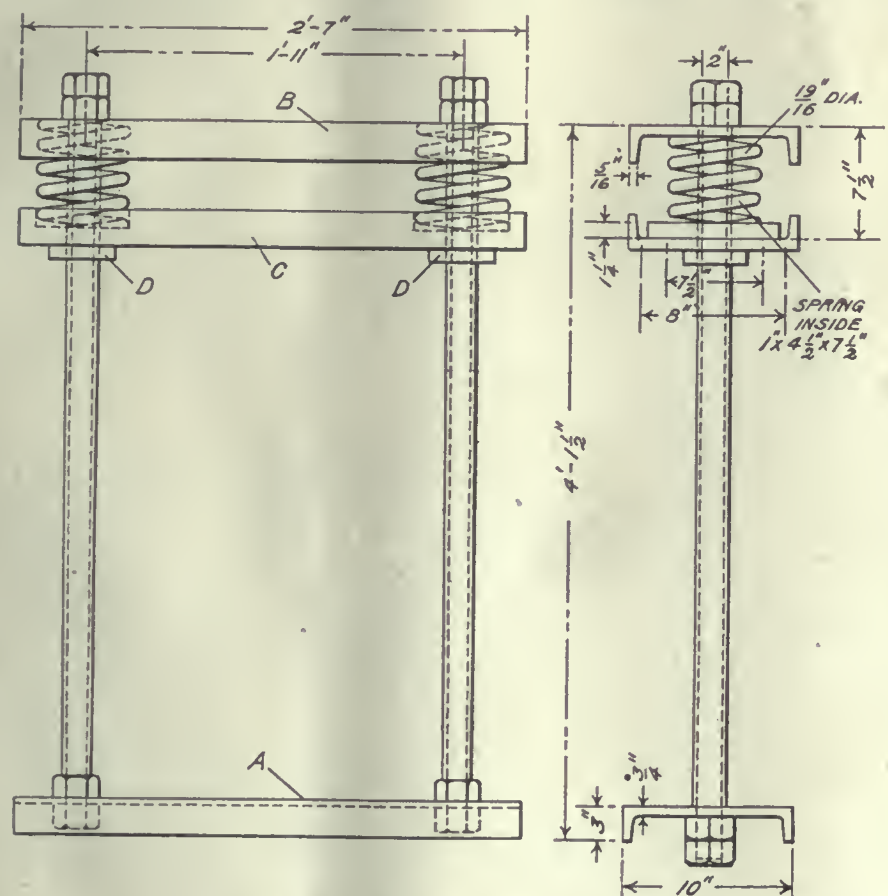


FLUE RACK FOR SERVING FLUE CUTTER

slide freely back and forth. These dogs are of steel with a row of case-hardened teeth at the top. One of these is used between each two adjacent shoes to be planed and one at each end of the row of such shoes. With the shoes and dogs in place, the whole system is drawn tightly together by the bolt (4) which runs from end to end of the whole chuck. The dogs are prevented from lifting out of the body by the grooves in the same into which they are fitted, and the dogs, biting into the metal of the shoes, hold them firmly in place. Again the two sides of the shoes are planed at the same time by the two heads to prevent any tendency to lateral displacement and by putting two sets of these chucks on a planer at once the machine can be worked to full capacity at all times.

Another handy wrinkle is a flue rack for receiving flues after the safe ends have been welded on. It consists of a rack having two runways (1), set about 4 ft. above the floor and on a slight incline. The length of the runway is 13 ft. 3 in., ending in a pocket. The contour of the pocket section is in the arc of a circle having a diameter of 6 ft. 2 in. As the tubes roll down the runway from the welding machine they drop into the pocket, which, when it is filled, holds them in shape for wrapping with a chain and forming a convenient bundle for lifting and carrying away with a crane.

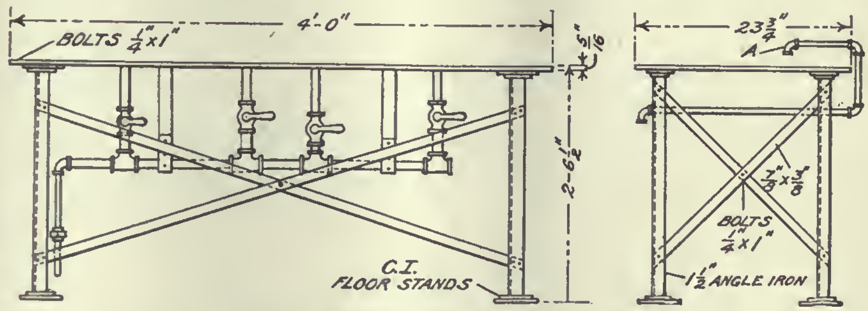
The testing of hydraulic jacks after they have been repaired is an important piece of work in order to determine whether the pump is working properly and the packing is tight. It is desirable, however, that in working up a pressure it should not be overdone, and that there should be some indication as to about what it might be. To accomplish this a rack has been erected for testing hydraulic jacks. It consists of two 10-in. channels A and B, tied together with two 2-in. bolts running through pipe separators. A third channel C rests on collars D, fastened to the pipes, and moves freely up and down over them. Between the two upper channels are two coils of heavy springs.



TESTING MACHINE FOR HYDRAULIC JACKS.

To test a jack it is set on the lower channel and the ram pumped out and against the channel C. As the pressure rises the springs are compressed and the load can be regulated accordingly.

In the blacksmith shop there is an air-cooling table for tools. It is formed of a plate of steel 4 ft. long, 23¾ in. wide and 5/16 in. thick supported on four legs made of angles and cast iron flanges. The height of the top of the table above the floor is 2 ft. 6½ in. The air is carried along beneath the table in a pipe from which four branches rise and pass through the plate of the table, each being closed by a stop cock. The tools may be placed on the table above a jet coming up from beneath or beneath the downward jet at A delivered from the pipe running up at the back of the table. The whole arrangement is very simple and easily made for any shop having occasion to use air-cooled tools.



BENCH FOR AIR TEMPERING OF TOOLS.

Safety on the Norfolk & Western.

From reliable data covering a period of five years the effectiveness of safety work on the Norfolk & Western affords a shining example. With a 42 per cent. increase in the volume of business, there was a 49 per cent. decrease in the number of employees killed, and a 41 per cent. decrease in the number of employees injured, and not one passenger had been killed in a train accident during the number of years referred to, although the railroad during that period handled 34 million persons.

Locomotives in Great Britain.

The number of locomotives available for traffic on the 16 principal railways in Great Britain in June, 1919, was 17,743, a decrease of 1,186 as compared with the number available in 1913. 429 Government locomotives have been loaned to the companies, and strenuous efforts are being made to reduce the number awaiting repair, and to increase the rate of construction of new locomotives.

Locomotives for Roumania.

Roumania has placed an order for fifty locomotives with the Baldwin Locomotive Company of Philadelphia, this being the first step taken toward improving the railways of this country which were destroyed during the war. Treasury bonds will be accepted in payment by the Baldwin Company for the locomotives.

Items of Personal Interest

T. W. Dow has been appointed general air brake inspector of the Erie, with office at Meadville, Pa.

F. A. O'Neill has been appointed road foreman of engines of the Erie, with headquarters at Cleveland, Ohio.

H. W. Heslin has been appointed master mechanic of the New Orleans Great Northern, with office at Bogalusa, La.

F. L. Carson has been appointed mechanical superintendent of San Antonio & Aransas Pass, with office at Yoakum, Tex.

G. Dempster has been appointed master mechanic of the Southern Railroad in Mississippi, with office at Columbus, Miss.

W. O. Nugent has been appointed superintendent of locomotive shops of the Canadian National railways at Transcona, Man.

John Burns has been appointed foreman boilermaker of the Chicago, Milwaukee & St. Paul, with office at La Crosse, Wis.

J. E. Brogan, master mechanic of the Atlantic Coast Line, at Waycross, Ga., has been appointed superintendent of shops at that point.

George C. Jones has been appointed general road foreman of engines of the Atlantic Coast Line, with headquarters at Florence, N. C.

B. B. Milner has been appointed engineer of motive power and rolling stock on the New York Central, with office at New York, N. Y.

F. T. Lee has been appointed traveling engineer of the Chicago, Milwaukee & St. Paul, with headquarters at Minneapolis, Minn., succeeding A. Z. Cowles, transferred.

W. G. Cook, manager of the Chicago office of the Garlock Packing Company, Palmyra, N. Y., has been transferred to the managership of the office at Philadelphia, Pa.

Ernest V. Williams, shop superintendent of the Buffalo, Rochester & Pittsburgh, has been appointed superintendent of motive power, with headquarters at Du Bois, Pa.

Charles R. Craig, purchasing agent of the Southern railway during federal control, has been appointed general purchasing agent of that road, with headquarters at Washington, D. C.

B. C. Nicholson, general foreman of the Denison locomotive shops of the Missouri, Kansas & Texas, has been appointed mechanical efficiency inspector, with headquarters at Parsons, Kans.

E. W. Thornley, formerly supervisor of stores, United States Railroad Administration, has been appointed assistant purchasing agent of the Baltimore & Ohio, with headquarters at Baltimore, Md.

D. C. Curtis, storekeeper for the Northwestern Regional Purchasing Committee, has been appointed general storekeeper of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis.

George H. Nowell, master mechanic of the Nelson division, British Columbia district of the Canadian Pacific at Nelson, B. C., has been transferred to the Lethbridge division, with office at Lethbridge, Alberta.

L. E. Fletcher, master mechanic of the Atchison, Topeka & Santa Fe, at Raton, N. M., has been transferred to a similar position on the Arkansas River and Colorado division, with headquarters at La Junta, Colo.

George A. Price has been elected treasurer of the American Arch Company, 30 Church street, New York. Mr. Price will also in addition to being treasurer continue his duties as assistant secretary of the company.

E. H. Pudney, signal engineer of the Atlanta & West Point railroad and Western of Alabama, has been appointed electrical and signal engineer of the Atlanta, Birmingham & Atlantic, with headquarters at Atlanta, Ga.

Frank W. Clark has been elected president of the Elvin Mechanical Stoker Company; John R. Given, vice-president; A. G. Elvin, treasurer; Frederick P. Whittaker, secretary; and J. Snowden Bell, patent attorney, 149 Broadway, New York.

F. W. Sinram, president of the Van Dorn & Duttin Company, Cleveland, Ohio, has been unanimously re-elected for the fourth time president of the American Gear Manufacturers' Association, at the recent meeting of the Association in Detroit, Mich.

T. C. Kyle has been appointed superintendent of motive power and equipment of the Batesville Southwestern, with headquarters at Batesville, Miss. Mr. Kyle will have charge of all mechanical matters, including jurisdiction over engineers and firemen.

John Purcell, assistant to the Federal manager during the United States Administration, has been appointed assistant to the president of the Santa Fe system, in charge of the mechanical department, with office in the Railway Exchange building, Chicago, Ill.

F. M. Crandall, assistant master mechanic of the New York Central Lines West of Buffalo, with office at Collinwood, Ohio, has been appointed master mechanic, with office at Ashtabula, Ohio, with jurisdiction over the Franklin division, including the Oil City branch, Ashtabula and Youngstown yards, and the Alliance division.

F. P. Pfahler, formerly chief mechanical engineer of the Railroad Administration, with office at Washington, D. C., has been appointed supervisor of locomotive maintenance of the Baltimore & Ohio, with office at Baltimore, and also the mechanical member of a committee investigating the feasibility of electrifying some of the divisions of the road.

Walker D. Hines' resignation as director general of railroads became effective last month, and he has accepted an appointment as arbitrator in determining the ownership of a number of vessels, formerly belonging to Germany, but given up by the terms of the peace treaty. Mr. Hines has also resigned from the chairmanship of the board of directors of the Atchison, Topeka & Santa Fe.

John Barton Payne, Secretary of the Interior, has been appointed by the President, Director General of railroads, in charge of the liquidation of the Railroad Administration, succeeding Walker D. Hines. Mr. Payne acted as general counsel of the Railroad Administration during its first year, and resigned to become chairman of the Shipping Board, which position he resigned to become Secretary of the Interior.

J. K. Nimmo has been appointed acting master mechanic of the Oklahoma division of the Atchison, Topeka & Santa Fe with headquarters at Arkansas City, Kans. H. W. Stevens has been appointed assistant general boiler inspector of the Western district of the Eastern lines, with headquarters at Topeka, Kans., succeeding Mr. Nimmo, and C. E. McMillan has been appointed road foreman of engines of the Eastern division with headquarters at Argentine, Kans.

Frank A. DeWolff, assistant locomotive superintendent of the Cuban Central, has joined the forces of the International Railway Supply Company, 30 Church street, New York, as a traveling representative. Mr. DeWolff has had an extensive experience in locomotive construction and repair, and in 1916 was appointed master mechanic of the Cuban Central, and in 1919 was promoted to assistant locomotive superintendent in charge of the locomotive and car departments of that road.

W. R. Scott, federal manager under the United States Railroad Administration of the Southern Pacific Lines, west of El Paso and south of Ashland, and the Western Pacific, has, since the return of the railroads to their owners, become president of the Southern Pacific System, Texas and Louisiana. Mr. Scott has had a wide experience in a number ot

W. R. SCOTT.

Western railroads and entered the service of the Southern Pacific in 1903 as assistant superintendent of the Sacramento division, and was latterly superintendent of the Salt Lake division. In 1907 he was superintendent of the Northern division, and in 1912 was appointed general manager, and in 1914 was elected vice-president, assuming its responsibilities in addition to his position as general manager in charge of operation and maintenance. Mr. Scott in his earlier days had seven years' experience as locomotive fireman, engineer and traveling engineer on the Santa Fe, and is in every way a fine type of the all-round, accomplished railroad man.

GEORGE E. LONG.

George E. Long, senior vice-president of the Joseph Dixon Crucible Company, retires after forty-three years of active and valuable service with the company, beginning in the capacity of stenographer and advancing to the offices of secretary, treasurer and vice-president, respectively. Mr. Long has aided much in the remarkable growth of the Dixon company's business during his long period of active service. He is recognized as the introducer of graphite lubrication as well as that of silica-graphite paint for protective purposes. Among the advertising fraternity he has been recognized for many years as an ardent advocate at all times of ample publicity to inform possible users of the Dixon products of their wide variety and utility. The company expresses its deep regret at his retirement, which was announced at a recent meeting of the Board of Directors, when he was re-elected as a member of the board, at the meetings of which the members hope to have for many years his continued and valuable counsel. Although having recently celebrated his seventieth birthday, Mr. Long still retains his great mental and physical activity in an eminent degree.

Joseph Robinson, Inventor of the Robinson Connector.

After an absence of more than two years, during which time he has had no managerial or official connection with the Robinson Connector Company, Mr. Robinson is again an active member of its

JOSEPH ROBINSON.

executive staff. He is the founder and was the first president of the company. Though not the first in the Connector field, he is credited with more effort in that art and, through the force and character of his work, with having done more to make the Automatic Connector the live subject that it is today than any other man. Born at Dayton, Washington, in 1889, educated in the common schools, Mr. Robinson has attained to no small success in his thirty years. He is a member of the patent bar and has had granted to him more than one hundred patents for various inventions the greater portion of which relate to Automatic Train Pipe Connectors.

In his new association with the Connector Company, Mr. Robinson is the co-worker of Mr. A. R. Whaley, Vice President and formerly Vice President of the New York, New Haven & Hartford Railway, a man of many friends and with many successes to his credit in the railway field. The RAILWAY AND LOCOMOTIVE ENGINEERING wishes Mr. Robinson and the Robinson Connector Company mutual success from their new association.

Obituary.

Daniel C. Noble.

The death is announced of Daniel Cram Noble, president and treasurer of the Pittsburgh Spring and Steel Company, Pittsburgh, Pa., in his 76th year. Mr. Noble was for many years identified with branches of the Pennsylvania railroad in Pittsburgh and vicinity, and in 1880 he became associated with the A. French Spring Company of Pittsburgh, and in 1902 founded the Pittsburgh Spring and Steel Company, which under his able management has been very successfully conducted.

Wilson Worsdell.

Wilson Worsdell, chief mechanical engineer of the North Eastern Railway of England, died at South Ascot, England, last week. Mr. Worsdell earned a high reputation as a constructing engineer, and introduced higher capacities both in British locomotives and freight cars. He was a director of the Westinghouse Air Brake Company, and was at one time president of the Association of Railway Locomotive Engineers.

Alco Flexible Staybolts.

The American Locomotive Company has issued Catalogue No. 10050, describing and illustrating the details of the Alco flexible staybolts manufactured at the company's plant, Richmond, Va. The plant is devoted solely to the manufacture of these bolts and other locomotive accessories. The company has had seventeen years' experience in the manufacture of flexible staybolts, and being constantly engaged in the designing and construction of locomotives have had excellent opportunities of perfecting the details to suit the varied requirements of locomotive service, as well as testing the materials looking towards perfection in detail. The fact that there are now 86 of the leading railroads in America, and 27 of the railroads in foreign countries that have their locomotives equipped with the Alco flexible bolts is the best proof of their reliability. The catalogue not only furnishes fine particulars in regard to the details of the stays, sleeves and other attachments, but there is a special section devoted to recommendations as to proper installations and replacements, as well as installation tools designed to simplify application and eliminate unnecessary labor. Copies of the catalogue may be had on application to the company's main office, 30 Church street, New York.

Vasco Vanadium.

Vanadium Alloys Steel Company, P. O. Box 1250, Pittsburgh, Pa., has issued a very attractive booklet descriptive of Vasco Vanadium tool steel. This booklet is full of valuable information gathered from long experience in the developing of ideal steel that should be stronger, tougher and denser than carbon tool steel. The company was a pioneer in the introduction of vanadium into tool steels, and years of experiment have proved that vanadium, which was first considered of value only as a deoxidizer, a scavenger, also imparts additional strength, toughness and density to steels.

Railway and Locomotive Engineering

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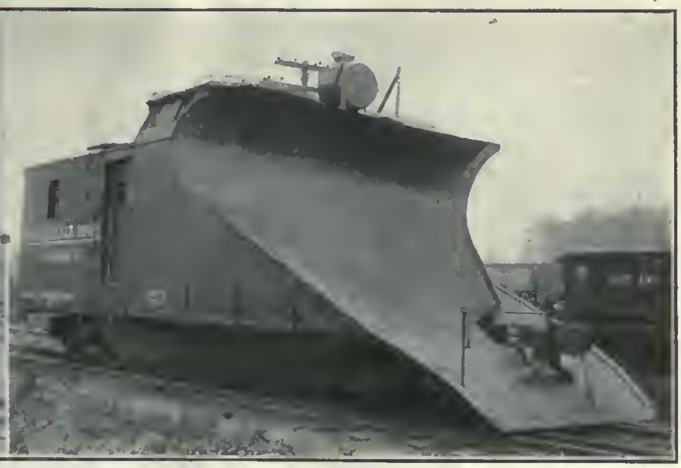
Snow Fighting Equipment

By W. H. WINTERROWD, Chief Mechanical Engineer, Canadian Pacific Railway*

The development of snow fighting equipment for the regular movement of trains during the winter months is due very largely to the Canadians and the Canadian Railways, although snow conditions in Canada are no more severe than those met on many railroads in the United States. The well-known Russell design of snow plow was first put in service in 1885 on the Intercolonial Railway and the rotary snow plow is the result of a development of the invention of Mr. J. W. Elliott in 1869 who was a dentist in Toronto. This was followed by the Jull rotary plow and the later developments by the Leslie Brothers. The first snow-plows built were those of the push-plow type which was a wedge-shaped wooden plow mounted on trucks and pushed in front of a locomotive. As these plows were frequently derailed because of a lack of weight, a plow was constructed utilizing the front end of a locomotive as a support which was called an engine plow and the illustration, Fig. 1, shows one of its applications as made in 1880. This plow was made of steel and such constructions are still in use at the present time. Sometimes such plows are permanently secured to the front of a locomotive which is assigned only to plow service, thus making a complete unit available at any time.

SINGLE TRACK STEEL PLOW—CANADIAN PACIFIC RAILWAY.



FULLER TYPE, SINGLE TRACK PLOW—PENNSYLVANIA LINES

The pilot plow was developed for use in light snow and sometimes it was constructed by merely filling in the slats of the ordinary engine pilot, a construction which was not always satisfactory because of the insufficient strength of the structure. Such plows are of very great value in keeping a line open where the snows do not pack hard or drift. Some types of the modern pilot plows are shown in diagrammatic form in the illustration Fig. 2. To obtain the greatest efficiency the angle formed by the mold plates should be fairly acute so that the snow will slide aside instead of being pushed along in front of the plow. From the pilot plow the step was a natural one to the construction of a regular push plow which is put upon a substantially built car and then pushed by one or more locomotives. Sometimes these plows are secured to the front end of a flat or ballast car. These push plows were frequently built V-shaped for simply throwing snow to each side without lifting it appreciably. They did not always prove satisfactory as the snow was pushed aside and if the drifts were deep or in cuts it fell back on the track after the plow had passed. This trouble led to the development of the square nose plow similar to that shown in Fig. 3. This is the well-known push plow of the Russell design. It is usually built of strong timbers re-enforced with structural steel. The framing on which the mold boards are laid has as its main feature a heavy timber called the backbone. Power is applied directly to the front of the plow through a steel re-enforced timber bar hinged or pivoted on the backbone. This bar extends between the two center sills the entire length of the car frame, having sufficient lateral movement at the rear for adjustment on curves. This method of transmitting power directly to the front of the plow is said to be responsible for the claim that the Russell plow is seldom derailed. The surfaces of the plow which come in contact with the snow have been developed to minimize resistance. The

*Abstract of paper read before the American Railway Master Mechanics' Association. Section 3 Mechanical.

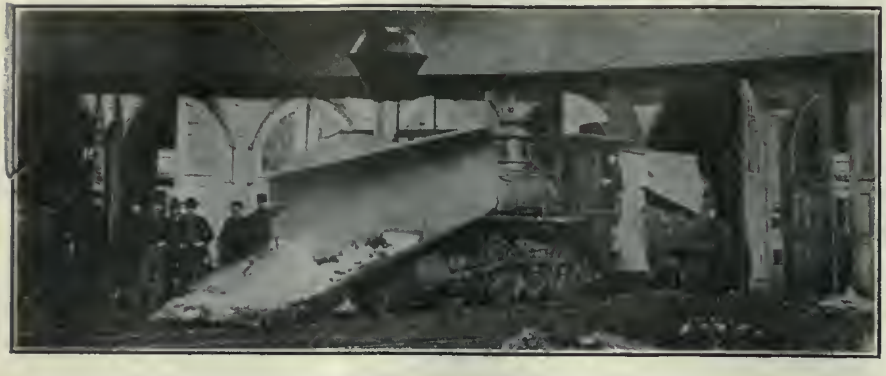


FIG. 1—ONE OF FIRST ENGINE PLOWS

back end of the car is several inches narrower than the front in order to relieve the car of snow friction against its sides. The top of the plow is fitted with a cupola or lookout from which its operation is controlled. The wings of the Russell plow are of the elevator type, and the face of each wing is formed into two concave shoots called elevators which slope upward at an angle of about 30 degrees. The flat nose lifts the snow from the track, thus relieving the machine of side pressure. It is then carried up by the elevators and the distance which it is thrown depends on the speed at which the plow is traveling.

Another design of push plow is that designed by Mr. Chas. Fuller, supt. motive power on the Union Pacific Railroad and known as the Fuller plow, an example being shown in our frontespiece. The framing is composed principally of wood and in addition to being mortised and tenoned is braced by brackets and held together by ¾-inch bolts. The mold plate is 11 feet wide and is of the square nose type. The vertical wedge and the horizontal wedge are constructed of continuous plate in order to eliminate angles, joints and riveting at the junctions of the two wedges. The nose of the mold plate is radiused downwards. The nose base is a triangular steel bar over which the cutting plate is placed. The front end of the plow can be raised or lowered and, when depressed, is carried on cast iron shoes which slide along the rail and are so arranged that they can be readily replaced in case of breakage. The car is of the ordinary box type equipped with doors and windows similar to other cars already described.

For many years the Canadian Pacific has constructed its plows of steel. It was the first railway to build and use an all-steel plow. The service given by this type has been very satisfactory. Such a plow has greater strength, costs less to maintain and affords greater protection to the men operating it than the wooden plow. They have been built for both single and double track operation and have been equipped with the drop nose, wings and in some instances with ice cutters and flangers similar to those applied to rotary snow plows; all the devices being controlled from the cupola. Two styles of these plows have been built. The Canadian Pacific steel plow shown in our frontespiece is used in territory where light and dry snows are frequent. On this type the roof extends forward over the mold plate to prevent snow flying upward. Another type does not have the extension roof and is used where snows are usually wet and heavy. The trucks are of the standard arch bar freight type using cast iron wheels and M. C. B. axles. The front truck is a special design using the Simplex truck bolsters the ends of which are fitted with a combination roller and wedge lateral motion device. This truck has no springs; the space usually occupied by springs being fitted with a wooden block. The first trucks used under these plows had no lateral motion arrangement and the trucks were mounted on engine truck axles with inside journals. The bearings and boxes were therefore practically inaccessible except when the plow was standing over a pit. This resulted in numerous hot journals and consequently the present truck with outside journals and a lateral motion device to overcome these troubles was designed. The rear truck only is equipped with brakes. The under frame consists of center sills made of 15-inch channels with top and bottom cover plates. The sides are of flat steel sheets 3/16 of an inch thick re-enforced by angle iron braces and bolsters. The ends are constructed of steel sheets of the same thickness and, attached to the side frames, are heavy corner angles ex-

FIG. 3—RUSSELL PLOW WITH WING ELEVATOR

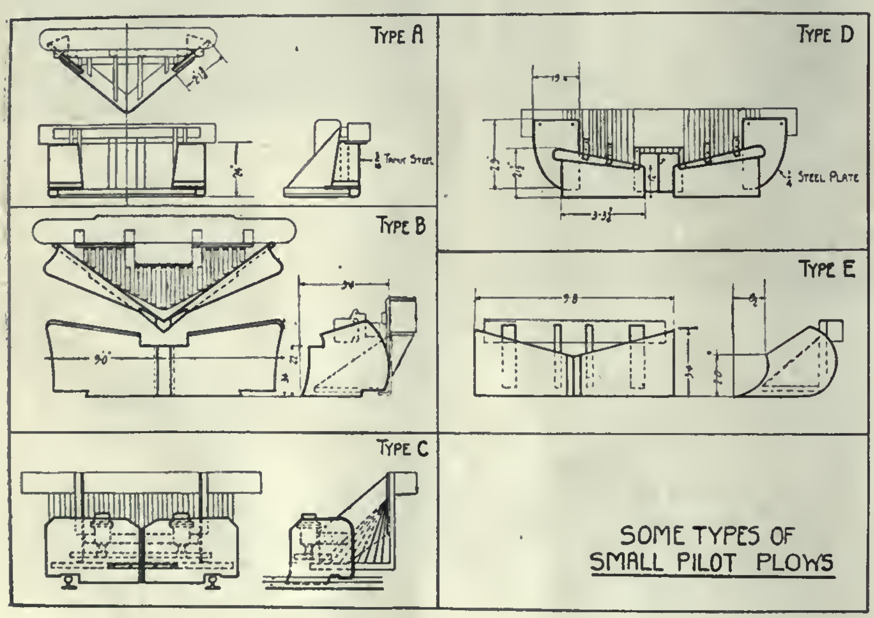


FIG. 2

tending from the bottom of the sills to the top of the side plate. The cupola consists of a steel frame made of plates and angles. The drop nose is a heavy plate carried on large cast-steel hinges. The plow side sheets extend from the front end of the lifting wedge to a point about midway betwen the trucks and they are very well braced and stiffened particularly at the lower edge, where contact with hard ice is likely, in order to resist inward bending caused by side pressure. At the back edges of the side plates there are steel extension wings which are attached by means of four heavy steel hinges. The width of the plow for the sides is 10 ft. and the width for the wings when fully extended is 16 ft. When folded these wings are flush with the side of the plow.

In addition to the ordinary plow there is what is known as the snow spreader or dozer, which is illustrated in Fig. 6. The front of the car is V-shaped and a low V-shaped plow with drop wings is attached to the front. When these wings are dropped into working position they form a continuation of the plow mold plates.

The simplest form of spreader consists of a flat car with wings attached to each side, these wings being operated from the floor of the car by means of levers. The drop wings are raised and lowered by air cylinders. The side wings are supported by jib cranes hinged to the side of the car and are held in working position by means of heavy bar braces. This type of spreader is sometimes used to widen cuts after a plain push plow has passed. When equipped with drag wings these spreaders are often called cut wideners.

FIG. 6—SNOW SPREADER

The first design of machine plows appears in a patent granted to Mr. J. W. Elliott in 1869 and consisted of a small four-wheeled flat car carrying an engine and boiler with a rotary plow attached to the front end, as shown in Fig. 7. This plow was to have been pushed by a locomotive but no machine of this kind was ever built. The first machine plow built was known as the Hawley Plow and was exhibited at the Philadelphia Centennial Exhibition in 1876. Then came what is known as the Marshall plow in which the wheel was revolved at right angles to the center line of the track. It was tried on one of the western roads but was a failure. Several other machines followed in an attempt to cut and throw the snow off the track by means of a revolving wheel.

The Elliott invention was improved by Mr. Orange Jull, who applied a knife or cutting wheel in front of the Elliott wheel and in 1883 the Leslie Brothers built the first rotary embodying the Jull modification. The fan wheel was mounted on a hollow shaft in which revolved a solid shaft supporting the knife wheel. The fan and cutting wheels were revolved in opposite directions by means of a gear system. During the winter of 1883-4 the Canadian Pacific Railway gave this model a trial at Parkdale, Ont. The preliminary trial in which the snow and ice were thrown over 300 feet demonstrated the practicability of removing snow with a revolving wheel but it also demonstrated that the plow should be constructed so that snow could be thrown to either side of the track and that a flanger was necessary to prevent derailment in hard snow and ice and to leave a satisfactory rail after passing.

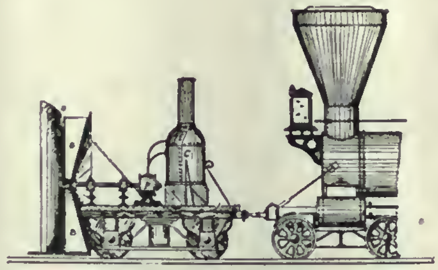


FIG. 7—ELLIOTT ROTARY PLOW

To overcome these objections the Leslie Brothers developed a wheel with manually reversible knives which could be changed in position to enable them to cut in either direction. They also applied a movable hood to the cylindrical portion of the casing through which snow could be thrown to either side of the track. In addition they designed an ice cutter and a flanger, which were applied to the front truck of the plow.

The ice cutters, one for each rail, were fastened to the front of the truck. That part of the cutter which dropped down inside of and about 2 in. below the rail head was shaped like a planer tool. That part of the cutter above the rail was shaped like the blade in a wood plane and in service position came within ½ in. of the top of the rail head. Two flangers, shaped very much like the mold boards of an ordinary farm plow, were fastened to the rear of the truck. These picked up the ice removed by the cutters and put it in the corner of the cut made by the rotary casing. The cutters and flangers could be either raised or lowered simultaneously by air.

A plow containing these improvements was built for them by the Cooke Locomotive Works of Paterson, N. J. This plow was put in service on the Chicago & North Western Railway during the winter of 1885-86. It is very interesting to note that the engines of this plow were equipped with Walschaerts valve gear. One difficulty, however, was experienced. The friction caused by the snow passing between the knife wheel and the fan wheel absorbed more power than that required to cut and throw away the snow. The principle of opposite revolving wheels was then abandoned and the Leslie Brothers designed a single fan wheel with adjustable cutting edges. These cutting knives were attached directly to the wheel and automatically reversed their position as the direction of rotation was changed.

Eight of these plows were built by the Canadian Pacific Railway in 1888. In 1889 Mr. Orange Jull devised a centrifugal excavator which was put into service on the Union Pacific Railway that same year.

This excavator was intended to remove snow by means of a cone-shaped screw conveyor. The screw was built up of plate and supported on a shaft. It was not only set diagonally across the track, but inclined so that the nose pointed down toward the right-hand rail. The shaft was supported by two bearings, the front one being located in the bottom right-hand corner of the hood; the back one in the left-hand corner. The screw was made up of four spiral blades of ½-inch steel plate. The action of the excavator was similar to that of an auger, the snow being carried back and up through an opening in the top of the hood. The screw was revolved at from 250 to 300 revolutions per minute.

The Jull plow was unsuccessful. The screw conveyor filled up solid with snow and ice; the spiral cutter was easily damaged by rocks and ice; the screw had a tendency to raise the front of the plow, resulting in derailment.

Although there has been considerable development, the general arrangement of the modern rotary is very similar to that of the improved Leslie plows. As development progressed, the plows became heavier and were made more powerful. The size of the cutting wheels has increased to such an extent that on the heaviest and most modern plows the knives will cut through small trees and successfully open up snow-slides containing a very large proportion of dirt, rock and gravel.

The first rotary plows, with the improved Leslie wheel, were equipped with a 17-inch diameter by 24-inch stroke two-cylinder engine. Steam was supplied by a locomotive type boiler having 1,259 square feet of heating surface and carrying 180 lb. pressure. The cutting wheel was supported by an 8½-in. diameter shaft geared to the engines. The shaft was supported in a main bearing 34 in. long.

These snow plows, as well as many other early rotaries, were equipped with a wheel of the fan type. The back of this wheel consisted of steel plate to which the fan blades, or partitions, were secured. The fronts of the partitions were supported by heavy inner and outer rings. The reversible cutters were supported by trunnions riveted to these rings. When the plow was in operation the revolving knives cut the snow and delivered it into the space between the partitions. The snow was then carried around the casing until the top opening was reached, through which it was thrown in a straight line by centrifugal force.

This fan type wheel is still in service on very many railways. It is the opinion of most users, an opinion endorsed by Mr. J. S. Leslie, that a well constructed, heavily built fan type wheel is the most efficient snow remover that has yet been devised.

On these plows the boiler, the engines, the main shaft and gears were supported on an underframe the sides of which were steel channels. At the front these side members were tied together by a very large casting which formed the bed for the main wheel shaft and the engine shaft bearings. Back of this casting two sills extended to the rear end sill. A wooden cab protected the engines and boiler. The plow, without the tender, weighed approximately 125,000 pounds.

The Leslies also developed a scoop type of wheel which was used to handle soft, fluffy wet snow found on the Pacific slope. Such snow had a tendency to clog the partitions of the fan type wheel. This scoop wheel was composed of ten cone-shaped radially placed scoops the back of which were fastened to a steel plate. The surface of the scoops is smooth to prevent snow from adhering. Each scoop is open its entire length on the front side and a cutting knife is hinged on each side of the opening. These knives adjust themselves automatically into cutting position.

The greatest test of a rotary snow plow is its ability to cut through snow slides. The plow can be subjected to no heavier service, a service which is occasionally required on all roads crossing the Rocky, Cascade and Selkirk Mountains. The snow in these slides is not only packed exceedingly hard, but often contains trees and rocks. It is impossible for rotaries to overcome such obstacles. It is generally customary to probe the slide with sounding rods to locate them and, if possible, they are removed by blasting or by being pulled out. Sometimes, however, these obstacles are not discovered and when the plow encounters them the ordinary cutting knives are generally damaged and the plow often put out of commission. The repair of the knives is generally difficult and slow.

During the winter of 1908-09 Sir George Bury, then general manager of the Canadian Pacific Railway Western Lines, decided that a plow was needed which would not break down, and he stated that he wished a rotary plow with cutting knives of 2-in. armor plate, and the rest of the plow built in proportion. The following spring authority was given for two such plows and arrangements were made with the Montreal Locomotive Works for their construction. The design was the idea of Mr. H. H. Vaughan, who thought that better results could be obtained by driving the plow wheel direct in marine engine style, and that the frame of the plow should resemble a bridge girder to thoroughly support the casing or hood. This idea has been justified as the plows operate with practically no vibration and the plan was incorporated into the plows, one of which is illustrated by Fig. 8 and which shows one of the largest and most powerful plows that has ever been built.

FIG. 8. HEAVY ROTARY PLOW ON CANADIAN PACIFIC RAILWAY

The design of a tremendously strong and rugged wheel was one of the most important problems. To have made the cutting knives and scoops of exceedingly thick plate, and all other construction in proportion would have resulted in a weight that was impractical. A wheel, however, was built which was quite different from any others and which was immensely strong.

The wheel was made of cast steel and as no facilities were available for machining or annealing the castings of the required size a built-up construction was used. The center castings were made in octagon form 80 in. across the flats, and was composed of eight segments which followed the curved form of a scoop wheel and had, at the outer edges, bosses six inches in diameter for 2½-inch diameter hinge pins. The main shaft of the wheel is 11⅛ in. in diameter and is carried by a front bearing of the same diameter and 28 in. long. Behind the front bearing is a marine type thrust bearing with ten collars. There is a rear bearing 10 in. in diameter and 16½ in. long. The thrust bearing which is peculiar to this plow is intended to take up the thrust ordinarily received by the back wall of the wheel casing. It has proved of decided benefit in service.

The engines are of the marine type and have cylinders 20 in. in diameter and 24-in. stroke. The steam chests are cast integral with the cylinders. The supporting columns are cast steel. As head room was limited, the connecting rods are short in proportion to the stroke, and the area of the cross-head bearing surfaces was increased accordingly. The crank pin of the engine was connected to a crank disc on the rear of the wheel shaft by means of a drag link coupling. This was used in case there should be any variation in alignment of the wheel shaft and engine crank shaft and to prevent any bending strains from being transmitted from one to the other.

The boiler applied to these plows is similar to those of the Canadian Pacific class M-4 consolidation type locomotives. It has 2,108 sq. ft. of heating surface and 44 sq. ft. of grate surface, and is of greater capacity than any boilers that have been used for snow plow service.

In working order, these plows weigh 260,000 lb. The weight is practically equal on the two trucks. The tender has a water capacity of 7,000 Imperial gallons and holds 16 tons of coal. The tender was made 32 ft. long over end frames, as, on account of bridge limitations, it was necessary to separate the weight of the plow from the weight of the pushing locomotives. The tender trucks are of the four-wheel, equalizer pedestal type, using standard engine-truck wheels and axles.

The performance of these plows has warranted their construction. One officer who has used them states that the knives are quite sufficient for dealing with small trees. They have cut trees four inches in diameter. He also stated that the slight angle at which the cutting knives are placed makes the plow somewhat slower in its progress through a slide, but the knives do not break when they strike obstructions such as rocks and trees. Fig. 9 shows the arrangement of the engine and the plow.

In order to properly clean up the track and to clear out the space between the rails for a depth of from two to four inches, flangers are generally used. Flangers are applied either to the front of the locomotive, temporarily to box cars or flat cars, or permanently to snow plows or flanger cars. These cars are similar to the ordinary box car type and are fitted with the Priest or Ray flangers. Then in addition to these they have ice cutters such as are shown in Fig. 11, which consist of 29 2-inch square cutting tools of hardened steel, ground to a point at the bottom end. These knives are carried in a flange channel which is fastened to the plow at the front of the spreader. This method of adjustment permits the entire cutter to be raised and lowered by the existing spreader mechanism. For removing ordinary light snows in yards a few roads have used the well-known street railway type of sweeper.

All snow fighting equipment should be in good condition before the start of the snow season. This is best accomplished by means of a definite summer repair programme. Snow fighting conditions vary greatly. Some roads, in order to determine the probable weather conditions, keep in close touch with the government observatories who advise the localities or areas in which storms exist or are probable.

Operation of equipment usually starts with the beginning of a storm. In clearing snow under ordinary conditions, pilot, push and wing plows are generally run at a good speed in order that the snow may be thrown well clear of the track. If a good speed is maintained, the plows will frequently go through a cut without stalling, whereas if the speed is slow the plow may catch or stall half way through the cut or drift, with the result that it may be stuck or buried and have to be shoveled out. Particular care should be used upon approaching a cut, particularly one with a side draft at the entrance, as with a double-track plow sufficient side pressure may develop to cause derailment. Such an approach is generally squared off before pushing the plow into it. If the snow is too deep for the plow to handle, it is leveled off by shoveling until reduced to a reasonable depth. The man in charge of the snow plow must be one with considerable initiative, as weather and snow conditions vary greatly and situations frequently arise which call for good judgment and quick decision.

Rotary snow plows are handled in an entirely different manner from the push and wing plows. Instead of depending upon speed to get through the drifts, the rotary plow approaches the drift slowly and the cutting wheel is fed into the drift instead of bucking it. A snow bank or slide is generally approached at a speed of about three or four miles an hour with the rotary wheel revolving about 150 revolutions per minute. When coming close to the obstruction the speed of the wheel is increased, and the pusher engines keep moving just fast enough to keep the plow up against the drift. If the pusher engine crowds the rotary too much the pilot signals the engineer of the rotary to increase the speed of the wheel. In case the pusher engine still crowds the rotary, the pilot should apply the air brakes to check the pusher. If the pusher cannot be checked with the brakes, the pilot should signal the engineer of the pusher to shut off. He should respond quickly to prevent stalling the rotary. In case the rotary is stalled the flangers are raised and the plow drawn back four or five feet from the cut.

When again ready, the wheel is started and pushed into the cut. The rotary plow should never be pushed into the bank from a distance of more than four or five feet, as failure of the rotary will result. If the wheel of the rotary becomes blocked with snow the plow should be stopped and backed up a few feet. The snow can then be loosened between the casing and the scoops, after which the wheel will clear itself. Rotary plows should not be forced through snow deeper than the hood. When the snow is deeper than the hood the top bank should be shoveled off. In slides or ice formations the top of the obstruction is frequently loosened by blasting.

The successful operation of the rotary depends greatly upon the manner in which it is handled, and it is highly essential that the men on both the rotary and the pusher engines should be experienced men.

For preventive measures snow fences are constructed at points where it is known that the snow will drift and these may be temporary or permanent. The usual style of snow fence is shown in Fig. 12 and is usually about seven feet high. The horizontal slats are attached to the top extension of the back braces to throw drifting snow backward and cause it to pile up on the outer side of the fence. Permanent fences may be of any recognized type but are usually of board placed close together, although in some cases stone fences have been used.

One of the Canadian roads uses spruce hedges and finds this a very satisfactory method of forming a snow barrier. The distance at which trees or hedges are spaced or planted from the track depends entirely upon local conditions. On the Canadian Pacific Railway, tree planting has been done in selected localities, species native to the locality being used. Along the north shore of Lake Superior

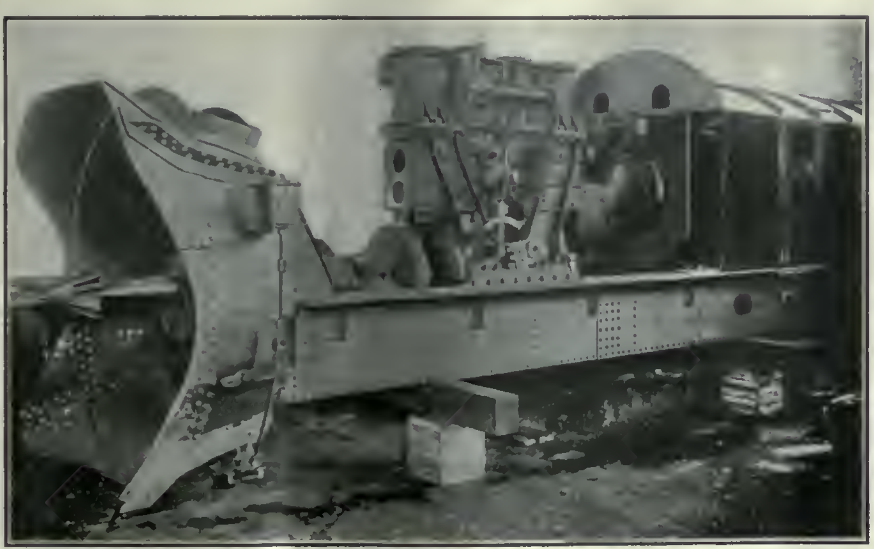


FIG. 9—ARRANGEMENT OF ENGINE AND WHEEL, CANADIAN PACIFIC HEAVY ROTARY PLOW

jack pine and spruce are utilized. In Quebec spruce and balsam and some cedar are used. The trees, when planted, are generally not over 30 inches in height. The practice of using hedges

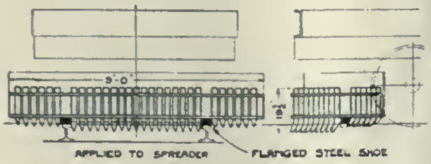


FIG. 11—ICE CUTTER—CANADIAN PACIFIC RAILWAY

and trees for this purpose is quite general in Europe. When properly planted, hedges and trees not only give snow protection but enhance the appearance of the right of way to a considerable extent.

On roads passing through mountain territory where slides are frequent, snow sheds are generally used for protection. Snow sheds are of various types and built to suit local conditions. The level fall type is of boxlike section and used simply to protect the road from falling or drifting snow. The valley type shed is generally placed against an embankment in such a way that a slide will pass over the roof of the shed without falling or damaging the track. The sheds are ordinarily braced with cribwork backed with earth or gravel. Several years ago, at Rock River, the Union Pacific Railroad constructed a very interesting permanent snow shed of concrete sections fitted together. This shed covered a track which had in previous years given a very great deal of trouble on account of deep drifting snow. The question of preventive measures is a very large one.

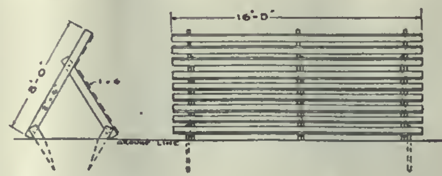


FIG. 12—SNOW FENCE—CANADIAN PACIFIC RAILWAY

The writer has not felt it within the scope of this description to more than make reference to the best known methods.

Motor Car for Railroads

In Service on the Mississippi River & Bonne Terre Railway

The accompanying illustration shows a motor car adapted for use on railroads, and is well suited for service as a private car, and could be used profitably on non-paying roads where the traffic does not call for the frequent service of heavy steam locomotives. The car was built and patented by J. F. Kehrman, master mechanic of the Mississippi River & Bonne Terre Railway, at Bonne Terre, Mo. The general dimensions and features of the car are as follows:

MOTOR CAR USED ON MISSISSIPPI RIVER & BONNE TERRE RAILWAY.

Cylinders, six, diameter 3¾ ins., by 5 ins. stroke. Total wheel-base, 10 ft. 8 ins., rigid, 3 ft. Swivel truck, 4 wheels, ball-bearing centre plate, no arch brace, truck built with studs. Air pump attached to crank shaft, and air brakes on all wheels. Equipped with whistle signal, horn, air sanders, and air drums attached to running board, 2½ cu. ft. capacity. Also equipped with hand brake on front truck operated by steering wheel. Tires of open hearth steel flanges and taper—Master mechanics' specifications. The car operates on 60 deg. curves, and is rated at 40 miles per hour on 1.80 grades.

The consumption of gasolene is about one gallon for 20 miles. In a trip of 63 miles over the Mississippi and Bonne Terre Railway, which portion is on an 1.8 grade with 10 to 12 deg. curves, the motor carrying seven passengers, three gallons of gasolene were used. Weather tops are being applied to the cars already in service which adds greatly to their appearance. It may be added that the car may be built with two or more propelling wheels according to the size required. The growing demand for the new service is already particularly marked and bids fair to prove a good investment.

Coal the Mainstay.

It is generally agreed that coal, by the decree of nature, must continue as our fuel mainstay; the dream of liquid fuel, cheaply produced and efficiently burned, may be but as a passing cloud over the sun. Already the demand for internal combustion engine fuels is outstripping the increase in the production of crude fuel. Coal will likely continue the popular source of energy, for economic reasons, if no other.

Making Phosphor-Bronze.

Where possible the use of phosphor-tin is usually the method used for adding the phosphorus in this alloy, but where this tin alloy is not available the phosphorus has to be added to the copper first, and then the required amount of tin is alloyed in, it being very inadvisable to make the Cu-Sn alloy first and then add the phosphorus. The copper should be melted and lifted from the fire and, after skimming, the phosphorus should be pushed under the surface with a proper plunger. Then as soon as reaction ceases the tin should be alloyed in and the metal poured.

Railway Club Secretaries.

At the annual meting of the Railway Club Secretaries held at Atlantic City, N. J., on June 11, the following were elected officers for the ensuing year: Chairman, W. E. Cade, Jr., New England Railway Club, Boston, Mass.; vice-chairman, W. A. Booth, Canadian Railway Club, Montreal, Que.; secretary-treasurer, Harry D. Vought, New York Railroad Club and Central Railway Club, 95 Liberty street, New York, N. Y.

International Railway General Firemen's Association.

The next annual convention of the above association will be held at Hotel Sherman, Chicago, Ill., September 7, 8, 9 and 10, 1920.

Annual Convention of the American Railroad Association, Section III, Mechanical

The Mechanical Section of the American Railroad Association which is the successor to the American Railway Master Mechanics' and Master Car Builders' Associations held its second annual meeting at Atlantic City, New Jersey, from June 9 to June 16. The proceedings were opened with prayer and an eloquent address of welcome by the Mayor of Atlantic City. Then came the annual address of the Chairman Mr. W. J. Tollerton, the Mechanical Superintendent of the Rock Island Railroad. In this address Mr. Tollerton took an optimistic view of the labor situation and expressed the opinion that the establishment of the Labor Board would afford a means for avoiding the serious disturbances that had occurred in the matter of railroad labor by affording a means of an orderly discussion and a just consideration by all representatives concerned.

He also felt confident that we would experience beneficial effects from the transportation act because there would be a more insistent demand than ever for railroads to operate under conditions of maximum efficiency and that when it is realized by the general public that the continued use of obsolete locomotives and antiquated terminals would result in a direct form of tax upon it as a result of higher freight and passenger rates; that means would be found to correct that situation. This would also lead to the systematic study of new appliances and he expressed it as the duty of all railroad men to keep themselves informed on all things of that character that are presented to them in order to reduce operating expenses. This can be effected, to a very large degree, by speeding up repair work. The shortage of railroad equipment will have to be added to very liberally during the next three or five years and as the large quantity of equipment needed cannot be obtained on short order the remedy will be to secure the utmost service from each unit now in existence. Therefore, if the time that locomotives and cars are held at terminals can be reduced the result will be equivalent to the purchase of a corresponding quantity of new equipment.

The difficulties in financing locomotive and car equipment as well as that of obtaining deliveries may tend to eliminate labor and fuel saving devices from specifications. Such a step should not be countenanced because coal is the most important item in the expense of locomotive operation and a policy that would tend to eliminate the means of saving coal cannot be justified. On this ground he argued that locomotive repair shops and terminal facilities should be improved and enlarged co-incident with or prior to the time of the receipt of new equipment. He called attention to the fact that in the previous address he had advocated the establishment of a joint testing and research bureau and now a committee has been appointed to study this matter and has submitted an elaborate report on the subject. Other committees have done notable work along the lines of improved

W. J. TOLLERTON

terminal facilities but have not been able to express any decided recommendations owing to the difference of opinions that have come to them. He concluded by saying that in giving consideration to various matters pertaining to railroad affairs the Association should realize that every problem which they discussed has a nation-wide importance.

MECHANICAL STOKERS

The committee reported that the mechanical stoker has evidently become a necessity from the fact that there are now in use on the roads in the United States more than 5,000 mechanical stokers. This has been due, to a certain extent, to two causes. One the great increase in the weight of the locomotives and the second that in 1912 a demand was made by the firemen that two firemen should be placed upon all locomotives which weighed more than 200,000 lbs. on the drivers. The committee issued a questionnaire to a number of roads using mechanical stokers and from their replies formulated certain statements regarding the situation. In regard to the type of locomotive in tractive power on which the stokers are used it was found to range from 51,000 to 131,000 lbs. From which it appears that locomotives with a tractive effort of less than 55,000 lbs. have not been extensively equipped. The application of the stoker has led, in some instances, to an increase in the tonnage rating of the locomotives to which they were applied. Some of the larger users report stokers to burn more coal than handfiring but to offset this there is an increased efficiency in the tonnage and speed. Some of this excess coal, that is burned, is due to stack losses and will probably be decreased when the firemen become better educated. As for the quality of coal used on engines the replies indicate that from 20 to 50 per cent of so-called slack is used and by slack is meant the material that will pass through a four mesh per square inch screen.

The questionnaire asked whether the users were in favor of coal crushers with a stoker equipment on locomotives and the answers were practically unanimous in the thought that the locomotives equipped with the mechanical stoker should make a complete machine and be capable of operating over a wide range of territory. Therefore it should have a crusher on the machine. It was suggested that coal might be prepared at the mines especially where these are owned by the Railroad but the changing conditions and the necessity of obtaining coal from widely different sources makes such a plan appear impractical. The investment needed for the establishment of crushing stations along the line would be from $6,000 to $12,000 at each coaling station. As to the range of coal that it is possible to use it has been found that semi-lignite and sub-bituminous coal can be used, that being the fuel used on the North Western roads which have a head value of from 11,250 to 12,500 heat units. Reports indicate that there are no difficulties in firing with this fuel if it is properly handled. Sometimes it may require a slight change in fire box or draft arrangement but they are usually insignificant and considered of little or no importance.

In addition to the stoker, coal pushers are applied on a number of engines by which the coal is brought down on the stoker without any handling on the part of the fireman.

Inquiry was made of the stoker manufacturers as to the number of locomotive stokers in service on March 1, 1920, which is represented in the following table:

Kind of Stoker	Mallet	Mikado	Santa Fe	Centipede	12-Wheel	Decapod	Consolidation	Mt. Type and Mohawk	Pacific	Total
Street	424	638	357	4	14	...	21	3	36	1,497
Duplex	422	1,139	441	..	..	123	22	28	20	2,195
Standard	120	338	36	..	33	...	21	162	21	731
Hanna	70	6	73	..	16	...	...	4	...	169
Elvin	....	...	19	..	..	...	...	...	...	19
Crawford	....	50	35	..	..	...	337	...	93	515
Total	1,036	2,171	961	4	63	123	401	197	170	5,126

Discussion.—In the discussion the opinion was expressed that, with proper regulation on a properly designed stoker, less coal for a given amount of work should be burned than with handfiring but this would depend to a large extent on the education of the fireman who should be thoroughly posted in regard to the laws of combustion and the methods of putting coal into the fire. Among the advantages of the stoker were the increased tonnage which was reported in a number of cases. The Atchison, Topeka and Santa Fe reported that they had made an increase of from 150 to 300 tons.

In connection with the stoker discussion the matter of the admission of air over the fire received a great deal of attention, and it was advocated that it was necessary in some cases to run with the fire door open. Objections were made to this and it was suggested that if air is to be admitted over the fire it should be done in small jets rather than through a widely open door.

Objections were made to a comparison between stoker and hand fired engines on the ground that the stoker firing does not begin to do its work until hand firing has about ended. This statement was made on the ground that when hand firing is at its best it will beat the stoker firing but this involved the use of a good grade of coal but a poorer grade of coal can be used with the stoker than with hand firing and get a larger capacity out of the engine. This very fact brings out very prominently that when the capacity of the fireman is exceeded it is unfair to make a comparison especially if fine coal is delivered to the fire box it will result in using more coal with the stoker than the heavy and larger lumps required with hand firing. But the results obtained depend very largely on the fireman. If he will take pains to adjust the stoker and watch his fire so that the coal will be evenly distributed, he will reach the terminal with a comparatively thin bed upon his grates.

Attention was called to a report of the Fuel Conservation Section of the Railroad Administration in which it was claimed that spark losses run as high as 40 per cent of the total amount of fuel put into the fire box and that the statement is practically correct is shown from the fact that at a test at the University of Illinois a loss of from 15 to 25 per cent was shown.

It was also stated that the use of the mechanical stoker had made it possible to open the nozzles on certain engines until they would not steam with a fire more than five or six inches thick but under those conditions the engine steamed perfectly. Where these conditions are maintained there is no difficulty in maintaining steam pressure even where the heavy tonnage is hauled over a very crooked line.

In discussing the matter of temperature and admission of air to the firebox, Geo. L. Fowler said that some investigations made a few years ago showed the necessity of being careful as to the way in which air is admitted above the fire.

The investigation that he had in hand was the determination of the temperature of the two sides of the inside sheet, the fire side and the water side. He made his first determination back of the arch and there found about what he expected, that the fire side was considerably hotter than the water side.

He, then, moved back beneath the arch over towards the back head, and to his astonishment found the fire side of the sheet was 50 degrees colder than the water side. The boiler was one that was used in the Chicago district where the roads use four tubes expanded through the firebox for steam jets for smoke prevention. He had taken these out to get them out of the way, and his first trial was about six inches ahead of one of these holes. The air was going into the hole gently, and turning and running around along the side of the sheet and keeping it cool. Simple blocking up that hole with a piece of asbestos, raised the temperature to where it ought to have been.

He found later, by putting the steam jet back and sending the air in such a velocity as to get it away from the sheet and into the body of the fire before the air was burned, he had no such trouble in the cooling of the inside surface of the sheet.

He went into another place, 12 or 18 in. ahead of the side sheet, but flush with the door. Mr. Anthony, of the American Arch Co., read a paper before the New York Railroad Club some time ago in which he made an estimate of what the temperature of that sheet ought to be, and his temperature agreed within 2 deg. F. with what Mr. Fowler had actually measured at that point. When the man opened the door, however, to fire the locomotive, the temperature of the sheet on the fire side dropped 150 deg. F. in less than 15 seconds, and he had never yet been able, as quickly as he could act, to catch the temperature of the sheet during the time that the man was opening the door. The simple matter of swinging the door was throwing so much cool air up against the side sheets that the temperature fell so rapidly that no instrument he could get would keep up with it. It would balance in a few seconds, but at the time the fire door was wide open the temperature was below anything he could measure.

In firing the boiler he also found the expansion of the tubes pushed the back tube sheet back slowly until it moved quite a measurable distance in comparison with the shell of the boiler. Then when the throttle was opened the fire burned very rapidly, and within a very few seconds the sheet moved back half as far again as it was moved during the whole period of firing up.

If you open the fire door under those conditions, the tube sheet shoots ahead as if it was shot out of a gun, and by careful manipulation of the back fire door and throttle you can move the tube sheet backwards and forwards, as you would a bellows. So this matter of the admission of air to the firebox may improve combustion, but unless it is done very carefully, it may have a very detrimental effect on the expansion stresses in the sheets of the boiler.

THE MODERNIZATION OF STATIONARY BOILER PLANTS

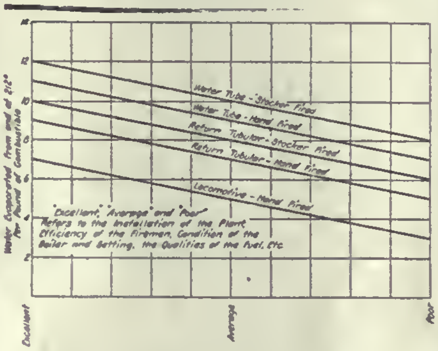
The committee called attention to the fact that 40 per cent of the country's total coal consumed or about 225,000,000 tons of coal were used in stationary boiler plants; that this is about 15 per cent more than that used for locomotive fuel and is probably more than it would have been had it not been that cheap fuel in the past has rendered users indifferent to the cost of power production. But much of this is undoubtedly wasted because, even under the most favorable conditions, there is a large amount of unpreventable losses and the point now is to so modernize the plant that these losses will be avoided. The committee therefore decided that an approximate standard should be established as a guide to results below which the efficiency should be regarded as unreasonably low and upon which practical results were still obtainable. In reviewing the character of the boilers used the report called attention to the fact that vertical, tubular and locomotive boilers have formed a larger percentage of boilers where steam requirements were small or intermittent. The vertical boiler has the advantage of occupying less space than the other types but both the locomotive and vertical types are more dangerous than water tube boilers designed for the same pressures. The boilers from scrap locomotives have formed a large proportion of power generators in railroad service and this fact of the low cost of their installation has probably contributed to their use regardless of their inferior economy. The efficiency of any boiler plant is dependent on the number of variables such as the load carried, character of equipment, etc., but there is a general definite ratio of efficiency between various types of boilers which have been indexed and from it a table such as shown in the illustration has been prepared. This shows the order of efficiency to stand: 1, water tube stoker fired; 2, water tube, hand fired; 3, return tubular, stoker fired; 4, return tubular, hand fired; 5, locomotive, hand fired and when these are rated on the basis of the amount of water evaporated per pound of fuel the following table shows what can be done.

Type of boiler	Evaporation from and at 212° per lb. of combustible
Water tube—stoker fired.......	10 lbs.
Water tube—hand fired........	9 "
Return tubular—stoker fired...	8 "
Return tubular—hand fired.....	7 "
Locomotive hand fired.........	5 "

The report dealt at some length with the excess of air that would enter the furnace and thus cut down the efficiency of the fire which might come from infiltration through the setting or too much draft through the fuel bed. It recommended that all leaks in the settling should be stopped with asbestos and front end leaks with cement. It called attention to the fact that soot is one of the best non-conductors of heat yet discovered and that thickness for thickness it will stop five times as much heat as fine asbestos and may involve a loss of as much as 7 per cent of the total amount of coal burned. The summary of the report of the committee in regard to this matter was as follows:

1. Eliminate air infiltration in settings by plugging cracks and applying a commercial boiler seal. 2. Apply adjustable dampers in the uptake of each boiler to permit draft control. 3. Apply a differential draft gage to each boiler. 4. Institute a system of periodical inspection of grates, brick walls and baffles. 5. Install automatic soot blowers in return tubular and water tube boilers. 6. Analyze the feed water to determine the amount of scale forming ingredients, and purchase a suitable treating compound based on guaranteed savings. Don't use a "cure all" compound. 7. Cover all exposed surfaces with a good commercial insulation. 8. Install feed water heaters in all plants of 100 hp. or over. 9. Use pumps, preferably outside packed plunger typé, for boiler feed purposes. 10. See that the boiler room force is instructed in the proper operation of the equipment and follow up the instructions by periodical check observations. 11. Employ only competent, intelligent firemen.

Returning to the matter of stoker firing it may be said in a general way that the under feed type of stoker is better adapted to secure large over load capacities than the others but it does not work satisfactorily on all grades of fuel, being better adapted to eastern grades of coking coal than to some of the western grades. Where the fuel supply makes it inadvisable to use this type of stoker it would be better to use the over-feed or chain grate type but wherever a stoker is to be applied local conditions should be most carefully considered. Especial attention should be paid to the layout of the piping to see that it is properly drained and thoroughly well covered with an insulation of high non-conducting properties. As for the type of insulation to be used it may be stated in a general way that thickness for thickness the maximum insulating value may be obtained for so-called felted asbestos covering, while 85 per cent magnesia yields only slightly less results in the saving cost. The upkeep cost of stokers will in general be higher than for hand fired furnaces but stokers make it possible to use a cheaper grade of fuel that is as high or higher economy than is obtainable with hand fired furnaces using a better grade of fuel.



In selecting the location for the railroad power plant, there are three important factors that should govern:

1. The plant should be located as near as possible to the center of distribution of the load it is to supply.

2. A siding should be provided close to the boiler room so that coal and ash cars can be so placed that long haulage and extra handling of coal and ashes will be cut to a minimum, thus keeping the labor costs for this service down.

3. Sufficient space for additional expansion to both the boiler and engine room should be provided.

Wherever steam piping is laid out into the yard it should be well insulated and protected from all climatic conditions.

Considerable data was given in regard to the use of pulverized fuel and from a report of the Fuller Engineering Company it appears that about nearly ten million tons are used annually for the industries of the country. Of this about from 100,000 to 200,000 tons are used for power generators. The preparation of the pulverized coal consists in crushing, drying, extraction of iron, pulverizing so that 95 per cent will pass through a 100 mesh screen and then mixing with the air and feeding into the furnace.

The two general methods adopted for this are: Where the coal is prepared at the same rate that it is consumed, another where it is prepared in advance sufficient to take care of a 24-hour run.

Under the latter method the pulverized coal is stored in a dust-proof hopper usually at the front of the boilers from whence it is fed directly to the burners and to the boilers. There are various methods of carrying it from hopper to the boiler, the screw conveyor and the pump being two. The storage of large quantities of pulverized coal is not looked upon as good practice and it is better to prepare the coal at about the same rate as that at which it is used.

In the design of the furnace great difficulties will be experienced with slagging if the brick work is too close to the deflagration zone, and the quality of the coal will largely dictate the furnace design.

All authorities seem to be agreed that low gas velocities are desirable and this depends, to a certain extent, upon the velocity at which the coal and air is conveyed to the furnace. When a fuel injection into the furnace is at a high velocity it tends to carry the combustion zone too near the tubes and causes considerable trouble with slag formations upon them. On the other hand if the velocity is not sufficient to carry the flame forward and away from the burner, difficulty with back firing will be experienced. As to the size of the plant, the use of powdered fuel should not be considered for one developing less than 2,500 horsepower.

A table of cost of pulverization shows that it ranges from 31 to 56 cents per ton, the latter being the figure for a daily capacity of 20 tons and the former the figure for one of about 1100. In certain boiler tests it was shown that the boiler efficiency ranged from 78 to 85 per cent and, as far as efficiency is concerned, that the comparison with the modern stoker gave an efficiency of 80.67 per cent as against 76.80 per cent for the stoker.

The nature of the fuel shows that the excess air used in burning pulverized coal can be cut down to a minimum but it is never quite practical to do this when the fuel is used in boiler furnaces because of the extreme temperatures which result.

In fact great care must be exercised to keep the temperature down, as such temperatures are not only detrimental to the brick work but cause trouble with slagging. Generally speaking the temperature of the boiler should run from 2400 to 2500 deg. F. when the boiler is operating under normal conditions.

The advantages and disadvantages of pulverized coal as a fuel are stated as follows:

(a) If ground sufficiently fine, the entire combustible content of the fuel may be burned, thereby effecting fuel economies hitherto not attainable even with the better grades of coals burned under favorable conditions.

(b) It permits the use of all grades of coal, including peat and lignite, with approximately equal degree of thermal efficiency for the same service, and increases very materially the energy which can be derived from the world's supply of coal.

(c) It possesses very largely the facility of control and combustibility of oil and gas fuels, thereby placing coal on a parity with those fuels.

The limitations of pulverized coal are:

(a) The very high temperatures attending its efficient combustion, and the unsteady mode of its deflagration, necessitating special furnace construction to secure reliable service and to realize the possible economies it affords, preclude its ready application to existing equipment.

(b) The operating cost and attention required to maintain the necessary apparatus for its use may more than offset the fuel economies that can be effected in small independent services.

(c) The presence of ash, which may not always be collected and held under control.

(d) The human element which will not submit to the peculiarities of its nature.

The report closed with a review of the use of crushed coal for furnaces where the crusher was of a roller type and the installation was made under a furnace at Purdue University. These were apparently quite successful and the results were summarized as follows:

1. It is not necessary to use dry coal. 2. Fineness of coal not essential. 3. Evidence indicates that furnace will burn any kind of volatile coal. 4. Furnace can be started in from one to two minutes. 5. Easy to operate. 6. Smokeless combustion. 7. Combustion conditions always under control. 8. Complete separation of combustible and non-combustible in furnace. 9. No banked fire necessary to intermittent load. 10. Great overload possibilities. 11. High efficiency. 12. Preheated air to secondary combustion chamber insures more complete combustion. 13. Instantaneous liberation from coal of heat of combustion.

In view of later tests made, the above merits were qualified as follows:

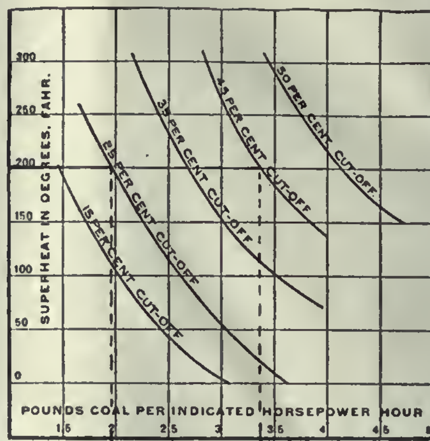
1. Combustion can be maintained with about 20 per cent moisture in coal fired. 2. Best results obtained with coal crushed so that 100 per cent will pass through a 50-mesh screen. 3. Will burn any kind of bituminous. 4. The amount of throwdown is a function of the fineness of the coal.

From personal observation, it can be stated that this test boiler and furnace were put on the line steaming at 105 lb. steam gage pressure in 47 minutes, with all conditions cold to start with.

There was no discussion of this report.

FUEL ECONOMY AND SMOKE PREVENTION

The report opened with a recommendation that reference be made to the publications of the Fuel Conservation Section of the Railroad Administration and especially to their pamphlet, "The Economical Use of Railroad Fuel." Then followed several pages of instructions in locomotive running which should be in the hands of everyone connected with locomotive operation. They embody a great deal that we are already familar with, but which should be kept constantly in mind by those who are charged with the responsibility of handling fuel on locomotives. Special instructions are given in the operation of superheater locomotives and especially in regard to the necessity of avoiding any entrainment of water into the superheater units. One of the points brought out is that a superheater locomotive should not be moved without having the regular air pressure in the reservoir and brakes in operative condition because if water should be carried over into the superheater all or part of it will flash into steam even if the throttle is closed. Under these conditions the locomotive is not under control because the valve chamber is filled with steam with no means of shutting it off. A diagram is presented showing the variations in the amount of coal burned per indicated horsepower under good conditions at varying degrees of superheat. From this it appears that with a 15 per cent cut-off and 200 deg. fahr. of superheat a horsepower should be developed of 1½ lbs. of coal. In a general discussion of the subject the report deals with the adjustment of the diaphragm draft plant, petticoat pipe, exhaust nozzle and the general efficiency of the locomotive. It suggests that when locomotives are stored and are equipped with a brick arch and where it is not necessary to draw the fires that the stack should be covered to retain the heat stored in the water and to prevent unequal expansion between flues and boiler which might result in leakage. A simple and handy stack cover which can



VARIATION IN COAL CONSUMPTION WITH VARYING SUPERHEAT AT DIFFERENT CUT-OFFS

be easily made is shown in the illustration. It can be placed over the stack from the floor and, when not in use, hung on the round house wall, one at each pit. Suggestions to locomotive engineers and firemen as well as to enginehouse followed.

A description of various types of nozzles was given, accompanied by a tabular statement of the results of certain tests made with them.

These tests were made on a Pacific type locomotive equipped with a Schmidt superheater and a brick arch. The same arrangement of front end details was maintained throughout the tests. With each design of nozzle, the evaporative

SUMMARY OF RESULTS OF NOZZLE TESTS

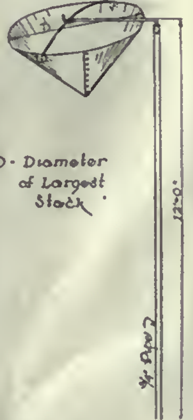
Description	Dry Coal Per Hour	Equivalent Evap. Per Hour	Average Least Back Pressure	Rank
Four Internal Projections	9,421	65,129	14.9	1
Rectangular	9,810	64,316	14.3	2
Circular—Area 33.29	4,218	49,249	9.2	6
Circular—Area 30.68	6,734	52,223	10.5	5
Alligator—12 in. high	5,292	47,852	9.6	11
Alligator—6 in. high	6,186	49,129	11.2	9
Four Vertical Projections	5,833	50,773	8.	6
Vertical Projection and Splitter	7,048	59,624	10.8	5
Four Notched Circular	5,003	50,833	8.1	7
Splitter	7,304	58,586	10.9	4
Special Shape	5,854	47,890	5.8	10

rate was increased until the boiler limit was reached, the usual observations being taken of boiler and engine performance.

The results of the tests corresponding to the various shapes of nozzles are shown in the accompanying table. They indicate that under the conditions peculiar to this test with a nozzle having four internal projections it was possible to obtain a higher equivalent evaporation per hour with less back pressure than with a circular or rectangular nozzle having approximately the same net area.

Conclusions

The committee does not consider the information now available sufficiently complete to justify positive conclusions as to the most efficient shape of nozzle, and is only in position to report that the circular form of nozzle does not result in the highest vacuum and the least back pressure. As to what form will produce those conditions it is impossible to say without an extended investigation involving a long series of test plant observations.



STACK COVER

It seems evident, however, that all preconceived ideas of exhaust jet action must be revised to agree with the apparent fact that the best results will be obtained when the jet contour is interrupted as is the case both with the internal projection nozzle and with the one having one axis longer than the other.

Some consideration was given to the front end appliances but, from the information at hand, it is not believed that a suitable general standard would meet practical requirements. It therefore appears that the best arrangement should be determined for each class of locomotives according to its normal service conditions and regular fuel supply. It recommends that diaphragm plates and stack extensions should be riveted or welded in positions and never changed except on the recommendation of the authorities establishing the correct relations.

It is probable that some fuel economy might be obtained in running stoker-fired engines over more than one division but the practice is not a prevailing one on the larger systems. While it may be practicable to increase the mileage of such locomotives the net economy of operation is doubtful.

Discussion.—There was very little discussion in regard to this matter and the greater portion of what there was was contributed by Mr. John A. Pilcher, mechanical engineer of the Norfolk and Western Railroad. He gave a brief description of some nozzle tests which were made upon the road and stated that, as a result of these, they were able to increase the size of their stack from 19 inches to 26 ins. in diameter and that, at the start, the engine had a back pressure of about 11 lbs. and approximately 8 ins. of vacuum in the smoke box. When the tests were completed they had about 8 ins. of back pressure and a 4-in. vacuum in the smoke box. Putting it in concrete form this drop in back pressure at a speed of 50 miles per hour, is equivalent to the addition of 300 horsepower to the engine.

Similar tests were made on the New York Central lines with the result that the engines have been running for a year and a half with a nozzle opening about 35 per cent greater than those of their sister engines running with plain circular nozzles. The nozzle developed here consists of a ring which is broken in 5 or 6 places so that there are as many streams of exhaust steam and the smoke box gases instead of being entrained in the exhaust jet and the circular nozzle on the outside of the stream only are entrained in between the several streams.

Safety Connections Between Engine and Tender

The report takes up the general design of draw bars between engine and tender and gives the formula for the determination of their size based upon the tractive force of the engine to which they are applied. The table shows the dimensions to be used for draw bars for different tractive forces with a factor of safety of 10, 15 and 20 and they are based upon a tensile strength of 45,000 lbs. per square inch for the higher tractive force shown on each line. They recommend that draw bars and safety bars and safety chains shall be refined wrought iron having that tensile strength. Steel is not recommended for these parts because of its brittleness and greater susceptibility to crystalization. The recommendation is made that all new locomotives should be built with a center safety bar located immediately beneath the draw bar except where construction prevents such an application. The central safety bar is unqualifiedly recommended for new locomotives and every possible effort should be made to so design them that this construction should be used. The committee is also of the opinion that safety bars are more satisfactory than safety chains for locomotives having a tractive force of 45,000 lbs. or more. The limit of 45,000 lbs. is set because safety chains for engines above that limit, would have to be of such size as to be impracticable and inconvenient. Where two safety bars are used they should be of such size that the working stress based on the normal tractive force of the locomotive should not exceed 4,500 lbs. per square inch in both bars considered together and the factor

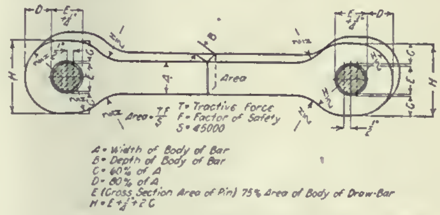


FIG. 1.—Diagram of Drawbar and Method of Determining Principal Dimensions.

Tables of Dimensions of Draw Bars for Different Tractive Forces at Factors of Safety of 10, 15 and 20

TRACTIVE FORCE	FIBRE STRESS 4500# FACTOR SAFETY 10						FIBRE STRESS 3000# FACTOR SAFETY 15						FIBRE STRESS 2250# FACTOR SAFETY 20					
	A	B	C	D	E	H	A	B	C	D	E	H	A	B	C	D	E	H
10,000 to 20,000	3	1½	2	2½	2½	6¼	3½	2	2⅛	2⅞	2¾	7¾	3½	2½	2¼	3	3	7¾
Over 20,000 to 30,000	3½	2	2¼	3	3	7½	4	2½	2½	3¼	3¼	8½	4½	3	2¾	3¾	4	9¼
Over 30,000 to 45,000	4	2½	2½	3¼	3½	8½	5	3	3	4	4	10¼	6	4	3	4	4½	10¾
Over 45,000 to 65,000	5	3	3	4	4	10¼	5½	4	3⅞	4½	4¾	11¾	6½	4½	4	5¼	5¼	13½
Over 65,000 to 85,000	5½	3½	3½	4½	4½	11¼	6½	4½	4	5¼	5¼	13½	7½	5	4½	6	6	15¼
Over 85,000 to 110,000	6½	4	4	5¼	5	13¼	7½	5	4¼	6	6	15¼	9	5½	5½	7¼	7	18¼
Over 110,000 to 135,000	7	4½	4¼	5¾	5½	14½	8½	5½	5⅛	6¼	6¾	17¼	9	6½	5½	7¾	7½	18¾

FIG. 2—TABLES OF DIMENSIONS OF DRAWBARS FOR DIFFERENT TRACTIVE FORCES, AT FACTORS OF SAFETY OF 10, 15 AND 20

of safety should not be less than 10. Where brackets are put upon the engine for holding the safety bars welding should not be permitted in applying supplementary brackets or equipment to facilitate the application of a central safety bar. This because of the uncertainty as to the strength of welds.

The report speaks of the desirability of using a straight rather than an offset draw bar and shows that with a straight bar on a locomotive having a tractive force of 35,000 lbs. the fibre stress per square inch of a straight drawbar is 1,984 lbs., while the factor of safety is 22, with the same cross section of bar and an offset of 8½ inches, the bar being 5 ins. by 3½ ins., the fibre stress is 26,632 lbs., giving a factor of safety of 1.4. The final recommendation on the report was that a request should be made to change the rules of the Federal law in regard to the inspection of locomotives and tenders. The law at the present time, reads "Two or more safety bars or safety chains of ample strength shall be provided between locomotive and tender, maintained in safe and suitable condition for service and inspected at the same time draw gear is inspected." The committee calls attention to the fact that a number of

Government standard locomotives were equipped with central safety bars so that there is no tendency to enforce the letter of this law, and to prevent confusion the committee, however, recommended that this rule be made to read as follows:

"One safety bar of same strength as drawbar, located immediately above or below drawbar, or two or more safety bars or safety chains of ample strength located one on each side of drawbar, shall be provided between locomotive and tender, maintained in safe and suitable condition for service, and inspected at the same time draw gear is inspected."

Discussion.—In the course of the discussion attention was called to the fact that during a period of ten years or more a drawbar, built up of six ½-inch plates riveted together, has been used on the Canadian Pacific Railway. The advantages claimed for such a construction is that if one plate fails the others will hold. Attention was also called to the fact that while the report recommends the use of nothing but wrought iron for drawbars there are many drawbars in existence today made of axle steel and further that the drawbar between the engine and tender should never be less in strength than that back of the tender where 12 square inches is the minimum section.

The factor of safety of 10 was criticised as too low to provide a proper safety and in reply to this attention was called

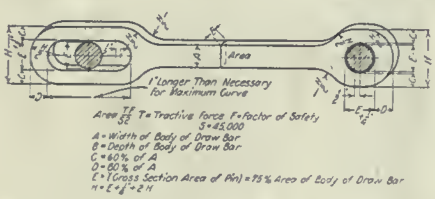
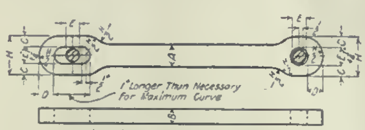


Fig. 3.—Diagram of Safety Bar (at side of Drawbar) and Method of Determining Principal Dimensions.



Tables of Dimensions of Safety Bars for Different Tractive forces at Factors of Safety of 10, 15 and 20

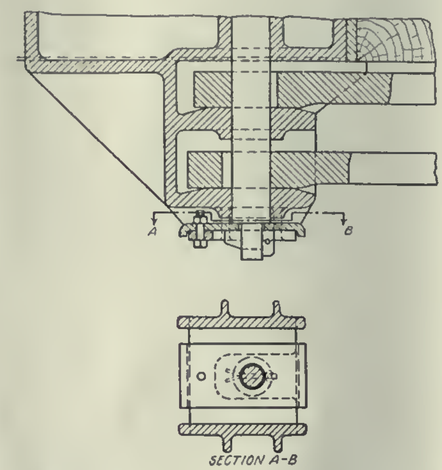
TRACTIVE FORCE	FIBRE STRESS 4500# FACTOR SAFETY 10						FIBRE STRESS 3000# FACTOR SAFETY 15						FIBRE STRESS 2250# FACTOR SAFETY 20					
	A	B	C	D	E	H	A	B	C	D	E	H	A	B	C	D	E	H
10,000 to 20,000	2	1 1/4	1 1/4	1 5/8	1 1/2	4 1/4	2 1/2	1 1/2	1 1/2	2	2	5 1/4	3	1 1/2	1 7/8	2 1/2	2 1/4	6 1/4
Over 20,000 to 30,000	2 1/2	1 3/8	1 1/2	2	2	5 1/4	3	1 3/4	1 7/8	2 1/2	2 1/8	6 1/4	3 1/2	2	2 1/8	2 5/8	2 3/4	7 1/4
Over 30,000 to 45,000	3	1 5/8	1 7/8	2 1/2	2 1/4	6 1/4	3 1/2	2 1/4	2 1/8	2 7/8	2 3/4	7 1/4	4	2 1/2	2 1/2	3 1/4	3 1/4	8 1/2
Over 45,000 to 65,000	3 1/2	2	2 1/8	2 7/8	2 3/4	7 1/8	4	2 3/4	2 1/2	3 3/8	3 1/4	8 1/2	4 1/2	3 1/8	2 3/4	3 5/8	3 3/4	9 1/2
Over 65,000 to 85,000	4	2 1/2	2 1/2	3 1/4	3 1/4	8 1/2	4 1/2	3 1/4	2 3/4	3 3/4	3 3/4	9 1/2	5	3 3/4	3	4	4 1/4	10 1/2
Over 85,000 to 110,000	4 1/2	2 5/8	2 3/4	3 5/8	3 1/2	9 1/4	5 1/2	3 1/2	3 1/4	4 1/2	4 1/4	11	6	4	3 3/4	4 7/8	4 7/8	12 5/8
Over 110,000 to 135,000	5	3	3	4	3 3/4	10	6	3 3/4	3 5/8	4 7/8	4 3/4	12 1/4	7 1/2	4	4 1/2	6	5 1/4	[illegible]

FIG. 4—TABLES OF DIMENSIONS OF SAFETY BARS (AT SIDE OF DRAWBAR) FOR DIFFERENT TRACTIVE FORCES AT FACTORS OF SAFETY OF 10, 15 AND 20

to the fact that if the drawbar at the rear of the tender has a value of only 12 square inches why should an engine that has a drawbar pull of 150,000 lbs. have more than 30 square inches because it does not seem logical that if a break occurs it will not be on the 12 square inches of section rather than that of 30 square inches. Then came the final criticism that if the average locomotive is constructed with a factor of safety of 20 or 22 why should the association go on record as endorsing a minimum factor of 10?

SUPERHEATER LOCOMOTIVES

Before outlining the recommended practice on above subject, we would like to present an item that received some



METHOD OF SECURING DRAWBAR AND SAFETY BAR PIN APPLIED FROM BELOW

consideration at one of the committee meetings, and about which it was not considered that, on account of the contradictory results obtained, this item should be included in the recommended practice. It is the matter of providing swabbing on piston rods. Very little concrete data were furnished the committee relative to the value of maintaining swabbing on piston rods, only one road reporting at length on this subject.

This road has been making a study of the value of swabbing on different types of piston-rod packings, the identity of which packings is withheld. The information that has been reported is shown in Table 1. On the 5-in. diameter rods considerably better service was obtained from packings without swabs. This was true in the first three types of packings mentioned, but on the "D" packing there was a slight difference favorable to the swabbing. On the 3¾-in. diameter rods the results are in support of the use of swabbing when we consider the results as a whole, but it will be noticed that exceptionally good service has been obtained from some of the packings without the use of swabbing. These results do not strongly support the opinion that piston-rod swabbing is essential to good service and, on account of the limited information that has been furnished along this line, your committee hesitates to make recommendation either for or against the use of swabbing.

Locomotives equipped with superheaters should, in general, be operated in the same manner as locomotives using saturated steam. The cylinder cocks should normally be open when the locomotive is standing under steam, and when the locomotive is started they should remain open until dry steam appears. In starting a superheater locomotive, the reverse lever should initially be placed for full travel of the valves, and at all times the water level in the boiler should be such that there will be no possibility of water being carried into the superheater. Water carried into the superheater will be evaporated into saturated steam or steam with a low degree of superheat, seriously affecting the economies available through proper operation; also water carried into the superheater may flash into steam after the throttle has been closed, placing the locomotive to that extent beyond the control of the engineman. Water carried into the superheater in quantities sufficient to reach the valves and cylinders will remove the lubrication from these parts and may result in knocking out cylinder heads or other damage.

Superheater locomotives should be handled only when the air brakes are in operative condition.

It is essential that the oil supply for the lubrication of the valves and cylinders on a superheater locomotive should be constant, as the high temperature will cause serious damage to these parts if there is an interruption of their lubrication. When locomotives are not equipped with drifting valves the throttle should be slightly open when drifting, in order to avoid the suction of hot gases into the steam chests and cylinders. The position of the superheater damper can be determined by observing the position of the counterweight attached to the damper shaft, and the engineman should know that the damper is wide open when steam is being used.

In the matter of the use of hydrostatic or force-feed lubrication the committee gave the subject considerable study and, for the reason that there is no definite information available on which to base conclusions, is unable to make any recommendations at this time. The committee proposes, if continued, to further study the subject and outline a program of tests to be followed on several different railroads, the data obtained from these tests to furnish a basis for drawing some definite conclusions as to the relative value of hydrostatic and force-feed lubrication.

The economical diameter of piston valves was also studied at some length, but as long as any variable is taken into consideration no one item can be fixed. For this reason no concrete recommendations can be made at the present time.

The discussion was limited to a few questions and answers the principal of which related to the height at which water should be carried in boiler. To this the committee stated that they could give no answer except that water should not be carried over to the superheater units and that if it were it would be indicated at once by the pyrometer showing a fall in temperature.

LOCOMOTIVE HEADLIGHTS AND CLASSIFICATION LAMPS

The committee made a report of progress in the course of which it stated that the incandescent headlight lamp has now been made practically standard on all the railroads of the country and that it is driven by a turbo-generator. In locating the generator of the engine there are four details that must be considered. In the first place short pipes are necessary, second, the location must be one that is accessible for inspection and operation, third, it must not in any way interfere with the vision ahead of the engine crew and the exhaust steam must not cloud up the front cab windows, fourth, it is desired to have the generator placed near the cab. At the present there is rather a strong preference indicated for the use of metal conduit for the wiring of cabs and this is general practice for all outside wiring. The use of a 250 watt 32 volt concentrated filament lamp for headlights of road engines and 15 watt 33 volt, special cab lamp for all lights in cabs, classification signals, markers, etc., is practically standard everywhere. For switching engine headlights there is a difference of opinion as to what lamp had best be used.

There is a growing demand for a headlight reflector that will not require such constant attention to keep clean as is necessary with the usual silvered copper reflector and the committee closed its report by recommending certain matters to be submitted by letter-ballot as recommended practice. These were that a 500 watt turbo-generator capable of developing 32 volts in full load at a steam pressure of 100 lbs. to be used. It should be located as near the cab as practical with a 250 watt 32 volt concentrated filament lamp to be used in headlights of road engines and a 15 watt 32 volt special cab lamp for cabs and other engine lights. That a dimmer should be used in connection with road engine headlights; that all wiring in cabs be in metal conduits and that all drops to be placed in ceiling of the cab back of and not over a boiler where possible. The discussion turned about the voltage of cab lamps and it was recommended by a representative of the Association of Railway Electrical Engineers that 33 volt be used instead of a 34 volt. At the present time there is a 34 volt cab lamp, a 33 volt train lamp and a 32 volt house lighting service all of which use the same lamp and the standardizing of everything at 33 volt would be of advantage to all concerned. In accepting the report of the committee they were instructed to work jointly with the manufacturers of headlight turbo-generators and the American Electrical Engineers in developing standards for this class of service.

FEED WATER HEATERS FOR LOCOMOTIVES

The interest in feed water heaters for locomotives has been somewhat retarded by the unusual conditions for the past few years but now, on account of the high cost of fuel, it is probable that the matter will receive greater attention than ever before. Reference was made to a valuable individual paper by Mr. J. Snowden Bell in the Proceedings of 1817-18. In this paper the author's conclusion was that "beyond question the feed water heater can and will be developed and adopted with the most substantial benefit in locomotive operation."

The feed water heaters may be divided into two classes, namely the closed and open heater. In the former the heat is transferred to the water through thin walls of metal, in the latter by direct contact of the steam with the feed water. The latter, of course, using an oil separator in order that the surplus oil may not be carried into the boiler. For the present, at least, no consideration is given to the use of waste gases from flues, but only the exhaust steam is taken as a heating medium. This because the two sources are independent of each other and require separate heaters. And secondly because the exhaust steam carries the larger portion of the waste heat being approximately six times that of the waste gases. This heat is more readily available and with the open heater especially it has been more successfully employed than that of the waste gas.

The committee has gathered and tabulated data obtained from various railroads which have used feed water heaters, namely the Pennsylvania, Baltimore & Ohio, Boston & Albany and the Canadian Pacific.

In some cases an attempt has been made to heat the water in the tender tank but this has not been satisfactory on account of the difficulty of pumping heated water into the boiler. It has been suggested that water having a high percentage of encrusting solids would make its heating impossible on account of the scale deposited. That may be the case with a closed heater but no more difficulty has been found with the open heater than with the injector.

From a number of tests made on the locomotive testing plant of the Pennsylvania Railroad with a Worthington design of heater it appears that on an average of seven tests with an open heater the feed water taken from a tank amounted to an average of 29,026 lbs. per hour. Into this 4,840 lbs. of steam was injected and condensed resulting in a delivery of 33,810 lbs. of water to the boiler. With an average consumption in the pump of 677 lbs. per hour. Taking the temperature of the steam and of the water this amounted to a recovery of 95,305 heat units per hour which amounted to 13.1 per cent of the total heat of the steam. Taking these tests as a basis of the economy of this heater it appears that, when the tests were run without the heater, the engine required 2.4 lbs. of coal per indicated horsepower per hour while with the heater only 2 lbs. were required showing an average coal saving of 16.1 per cent. The feed water temperatures were favorable to the heater in these tests as they were very cold and ranged between 39 and 41 degrees while the water delivered from the heater ran from 178 to 211 degrees indicating a temperature rise of from 137 to 171 degrees.

Because of the decreased draft when steam was taken for feed heating the exhaust nozzle was reduced from a diameter of 7 inches to 6¾ inches. This was found necessary in order to obtain sufficient draft.

As would have been expected the decreased combustion rate resulted in a lower degree of superheat when the heater was in use. This decrease was between 30 and 40 degrees. The rate of evaporation of 52,475 lbs. per hour and an indicated horsepower of 2,650 which were obtained with the heater are far beyond the usual operating requirements of the locomotive with which the test was made. The work of the boiler in evaporation is reduced in proportion to the amount of heat recovered but the saving in coal is greater than this on account of the boiler being operated at more efficient rates with the heater than without.

The steam used in the feed pump is of course a direct charge against a heater but this steam which is between 2 and 3 per cent by weight of the total steam produced by the boiler is delivered directly into the heater.

A test of the open type heater was made in road service from which it appears that the average evaporation per lb. of coal for the east and west bound trips was 9.05 lbs. without the heater and 10.35 lbs. with the heater. The temperature in the tender tank being approximately 50 degrees in both cases and the temperature of the water as delivered from the heater averaging 194.5 degrees Fahr. This shows an increase in evaporation per lbs. of coal of 1.3 lbs. or 14.4 per cent. There is no reason to expect that there will be any decrease in the efficiency of the heater after a period of service.

Tests were also made with closed heaters of two types one having a heating surface of 113 square feet and the other 121 square feet. In the former an average of 38,744 lbs. of water were taken per hour from the tank and delivered to the heater. In the latter 38,534 lbs. In the former the coal burned per indicated horsepower was 2.49 lbs., without the heater of 2.05 lbs., with the heater showing a saving of 17.55 per cent. In the larger heater there was the same coal consumed without the heater and 2.1 lbs. with the heater showing a saving of 14.88 per cent.

The Baltimore and Ohio Railroad made a trial of the Caille heater which is one of French make of the closed type using exhaust steam. This heater was not very satisfactory for examination, cleaning or overhauling and was abandoned on account of its faulty design which led to frequent failures and expensive maintenance. There was considerable trouble in maintaining the many parts. The pump was of insufficient capacity to feed the boiler when working hard and the injector had to be used as an auxiliary and at regular intervals.

The Boston & Albany made a six months trial of a heater and commented upon it in part as follows:

The cost of maintenance of the feed pump will be more than that of an injector and the same holds true of piping valves, etc. There is no evidence that the use of the heater instead of the injector increases the heating power of the locomotive. The removal of the exhaust steam for use in the heater reduces the draft by about 2½ inches of water, on an average, which naturally reduces the back pressure in the cylinders. There were various other objections raised to the use of the heater and the report closes with the statement that as far as the particular engine tested on this road is concerned they did not find any saving in coal or water due to the use of the heater and it is believed that it would make a better showing on a level road than on the Boston & Albany where considerable drifting is done.

The Canadian Pacific reported that they were experimenting with a heater of their own design and that a considerable amount of experimental work would have to be done before a heater would be discovered suitable for work on this road.

Discussion.—It was brought out in the discussion that there are more than 10,000 locomotives equipped with feed water heaters in Germany alone and the number is being increased at the rate of 2,000 per year. The Knorr system is the standard and is being applied to both old and new locomotives. A large number of engines are also equipped with these heaters in Switzerland, Holland and Belgium while in France the Caille-Potonie System is used. It is also reported that these heaters are in service in Tunis, Belgium, Roumania and Turkey. Very little has been done in England. The testimony given by other members on the floor was to the effect that while the heater presents great possibilities, the equipments have not all been satisfactory.

THE LOCOMOTIVE AS AN INVESTMENT

This was an individual paper presented by Mr. G. M. Basford and was an elaborate review of the locomotive situation with an urgent argument for the improvement not only in the equipment and design of new locomotives but also for the modernizing of old engines which are now uneconomical. The first point brought out was that it was necessary to haul more ton miles per hour by the individual engines as the only salvation for the railroads and that this calls for not only the best locomotives but the best use of the same and for quick and continuous movements, reduction of idle hours, quick terminal movements, improved dispatching, improved maintenance and repair facilities and repair methods and also for fuel and labor saving improvements of every possible kind. He formulated a prophecy that the steam locomotive is here to stay as it is the most vital influence in the progress of civilization and that it is capable of producing a draw bar horse power hour for 2.25 lbs. of coal at a speed giving the maximum power of the engine.

The importance of overhead charges were elaborated upon and attention was called to the fact that the value of the locomotives used upon our railroads is equal to 60 per cent of the total value of all of the machinery implements and tools of all of the other industries used in the country. If a manufacturer has tools costing from $25,000 to $100,000 he takes pains to keep them busy because unless they are running at all times the overhead charges of running this machinery will lead straight to bankruptcy. The true significance of overhead charges needs to be emphasized in all railroad activities. In the past the officers have not given it the attention which it deserves. The way to meet them is an increase of production and that is to make the engine pull more tons per ton of coal, per ton of its own weight, per dollar of charges, per hour in the day, per year, per dollar of shop terminals and track investment and per mile run.

In order that this may be done to the best advantage the motive power chiefs should be supreme in their own department, and should have the rank of vice presidents upon the roads. This is a matter that has been urged for many years and it is because of the failure to raise these men to such positions that much of the present inefficiency is due. When it is considered that the mechanical policy of the railroads, using 26.5 per cent of the fuel of the country, involves a technical responsibility for upwards of 6 billion dollars worth of property and for more than $4,000,000 spent per year in repairs it might with profit be presided over and administered by officers of the standing of vice presidents. If this is not done the railroads will continue to lose men whose knowledge, experience and ability alone can meet the situation.

It is not so much the cost of locomotives and equipment that is important as it is that a profit should be made upon that cost. Railway executives have realized this in electric installations and these have not been hampered by any such traditions as exist with steam locomotives where the engineers have been allowed a free hand to produce the best economic results; and, in ordering locomotives, it would be well worth while to order them on the basis of a certain minimum amount of work with no restriction put upon the cost, something which has thus far not been done.

In considering the details attention was called to what might be done by a modification of certain parts of the engine. Taking up the subject of classes A and B of the Administration engines it is found that the dynamic augment at 54.2 miles per hour is equal to 50 per cent of the static weight on the main wheel. But by the use of high quality steel forging for reciprocating and rotating parts it would be possible to reduce this unbalanced weight on the main wheel to more nearly zero, which would also help the overbalance in the other wheels. In like manner the heavy mikado might be made to put less stress upon the track than the light mikado retaining its present construction.

About 8 years ago the methods of boiler construction were changed from the empirical to the exact and new rules for boiler designing were laid down. Locomotive combustion has been studied as it never was before.

This has revealed the relative value of fire box, combustion chamber and tube heating surface, and has thrown new light on the subject of air supply to the fire.

There is scarcely an item that goes to make up an efficient and safe locomotive that has not been improved and many of these improvements are quite applicable to old engines, which, if they were made, would bring these old engines up to the standard of efficiency of the latest designs and would at the same time create a better feeling among the enginemen who become discouraged when they are placed upon engines whose possibilities of efficient operation are below the standard of the modern engine. Attention was called to the propaganda of the electric locomotive partisans who, in their arguments for the electric locomotive versus the steam, base it on the performances of old locomotives rather than those of today. Whereas the truth is that, in the past 5 years, the economy and capacity of steam locomotives has more than doubled. Attention has been called to the replacement of steam locomotives by electric but we have not heard anything about the small number of steam locomotives that have replaced a much larger number of engines of an early period.

In considering the rebuilding of old engines or the scrapping of same it might be advisable to scrap some of the old shops and in making comparisons between the past and the present it would be well for motive power officials to make a careful comparison between the cost of locomotive maintenance in old shops and those having the latest facilities.

The same may be said of locomotive terminals which are not all equipped to handle engines promptly and economically. Congestion at the round-house and in terminal yards is frequent simply because the round-house has not been kept up to the requirements of the situation. Adequate locomotive terminals laid out, organized and equipped for quick thorough work will speed up the entire railroad and this will make it a possibility to effect a better utilization of power. It is also suggested that passenger divisions might be extended to 300 miles and freight divisions to 200 miles. There are difficulties in the way but it would seem to be better to change crews and keep the engine running than to permit of so much idle time as there is now at division terminals.

We must bear in mind that coal will never again be cheap and that these economies can only be effected by a carefully sustained follow-up policy. In one case a superintendent of motive power has kept a careful record of the annual expenditures on certain classes of repairs and whenever any one of these classes reaches or exceeds $100,000 per annum he assigns an expert service man to report to him, whose duties are to insure a proper application, maintenance and use of the items in question. Such a policy will safeguard the money already spent. This involves a constructive, consistent and persistent plan, and every railroad should see that employes are wisely selected, properly trained, promoted by merit and from the inside to fill all important positions.

The small proportion of apprentices to mechanics at the present time is one that should be carefully considered. It stands at 18.58 mechanics for every apprentice which is not enough to supply men for the development and sustaining of the work on the railroads. Then there are the new things which will require close and vigorous attention and these are the 8-hour day, time and a half for overtime and from 100 to 200 per cent increase in wages and fuel cost.

Discussion.—In the discussion the points brought out by the paper were emphasized by a number of speakers. Especial attention was called to the small percentage of apprentices to mechanics. It was claimed that the ratio should be one apprentice to 5 mechanics instead of 1 to 18.58 and this is possible because it has been incorporated in most of the schedules. On some railroads the proportion is as low as 1 to 300 for some trades and as low as 1 in 31 for all trades taken together. It is said that we could never again have cheap coal and it is probable that the same may be said of cheap labor. On railroads which have been able to maintain their equipment with economy with mechanics at 30 to 40 cents per hour, common labor at from 17 to 25 cents per hour, and apprentices at 12 to 21 cents will find the same methods of maintenance very wasteful and excessive with wages of mechanics running to 85 cents and $1 per hour. The only way in which this condition can be met is by an improvement in facilities. When from 20 to 25 per cent of the motive power is standing idle it does not help matters permanently to buy more locomotives. Congestion is simply increased and the mechanical department receives an extra handicap. Therefore, instead of ordering new locomotives to tide over a period of heavy business the thing that ought to be done would be to increase the facilities for taking care of the motive power already on hand.

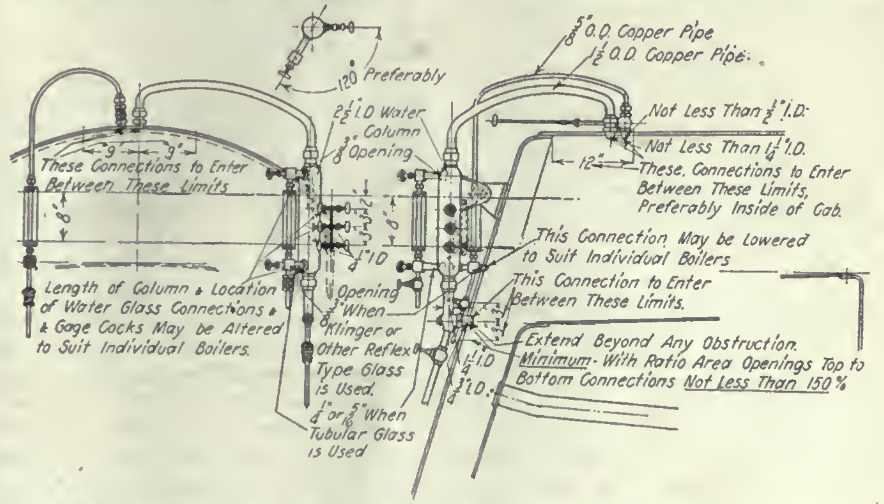
DESIGN AND MAINTENANCE OF LOCOMOTIVE BOILERS

The report opened with a review of water glass situation on locomotive boilers which it considered in the light of a comparison between the plain tubular glasses and the reflex. In this it was stated that the tubular has less visibility but a lower maintenance cost and some roads reported that, after a trial, the reflex glass was unsatisfactory but both types of glass have their adherents. Regrinding of reflex glasses was reported as successful by 4 roads, with fair results by 2 of them, and a success by 3, the cost varying from 7½ to 45 cents per glass. Specifications drawn up by the New York Central and the Pennsylvania Railroad were reported as in use by a number of roads. The use of the water column is both satisfactory and unsatisfactory, evidently depending upon the way in which it is applied. Drawings were given showing the arrangement of water glasses and standard gage cock as developed and approved by the Committee of Standards at Washington.

In the matter of beading tools for boiler tubes it appears the essential detail of the tool is the throat or surface from which the bead is formed and the radius of that surface is reported as from ⅛ in. to 11/64 in. The reports received indicate that there is a wide variation of practice without any apparent necessity for such variation and the committee asked for the views of the association as to the advisability of preparing and submitting a set of tools for this work.

The blow-off cock appears to be located in various positions of the boiler, some in the cylindrical portion and some in the water leg of the fire box. Very few troubles were reported in the use of the blow-off valves. In some cases a strainer is used to obviate obstruction from scale and sludge. In one case the valve was placed 12 in. above the mud ring, for the purpose of leaving the scale and sludge in the water leg, when blowing out.

There was a variety of opinion expressed in regard to the value of the combustion chamber taken as a whole on the ground that the cost of maintenance frequently overbalanced any fuel economy obtained by its use. One opinion was expressed that the use of the combustion chamber relieved flue troubles, in others this did not seem to be the case. The troubles reported from combustion chambers include the collection of cinders therein and the warping and cracking of the sheets. But it is the view of the committee that on large modern engines a combustion chamber is practically a necessity as a function of proper wheel bases and the weight distribution. The



RECOMMENDED PRACTICE ON APPLICATION OF GAGE COCK AND WATER GLASS FIXTURES minimum distance from the crown sheet to the inside wrapper sheet varies from 20 inches to 25 inches.

Fourteen railroads reported the use of no special devices to prevent the water entering the dry pipe while 4 use a special throttle with an inlet at the top of the dome. Three roads reported the use of special devices for promoting circulation and there was a claim that the Harter circular plate for promoting circulation gave a resulting economy.

The replies to the committee's circular give evidence that tubular water glasses are more popular than the reflex; that the grinding of reflex glasses is of doubtful value; that the beading tools in use are quite similar and should be usually standardized; that the number and location of blow-off cocks depends on the service and the quality of water used; that combustion chambers improved combustion, promote fuel economy but are subject to maintenance troubles unless carefully designed and that no conclusions can be drawn regarding the proper water and steam space above the crown sheet.

It was recommended that a specification covering tubular and reflex glasses, and bulls eye glasses for lubricators be presented and an endorsement was made for the water glasses and gage cocks as shown in the illustration.

Discussion.—The principal part of the discussion was presented by Mr. A. G. Pack of the Interstate Commerce Commission who presented in detail the results of a number of tests made by the I. C. C. and which can not be clearly shown without the aid of illustrations and these will be shown in a future issue. The balance of the discussion was taken up in the consideration of the combustion chamber in which it was generally acknowledged that there was a marked economy in coal consumption and that the maintenance of the same can be kept within reasonable limits by care in designing and maintenance. In one case the cracking was stopped by chamfering off and cutting away the excessive material in the seam. Where two engines of the same class are in use one with and one without the combustion chamber it is found that those without it give more trouble with leaking flues on account of the flame impringing directly upon them.

ENGINE TERMINALS, DESIGN AND OPERATION

The committee offered a report of progress and made no general conclusions or recommendations. It gave an outline of the practices of different roads and in connection with round house work expressed the opinion that adequate equipment with labor saving devices will repay the expense of installation in a short time and that round house should be equipped with proper ventilation. It was also pointed out that in drying sand when it is done with a stove the organic matter is burned out and the sand made more gritty. Steam heating for round house work evidently had the preference among the roads reporting. In the case of round house equipment several roads reported the desirability of separate drop pits to handle tender truck wheels. As for the material for round house flooring preferences were divided between concrete, creosoted block, brick and mastic or asphalt composition. In the matter of lighting the preference is about evenly divided between the reflector lights on the walls and lights placed between the pits.

Discussion.—In the discussion it was suggested that the committee should in a future report make a recommendation for the sequence of operations of an engine approaching a round house. And that a question which affects those operating in cold climates very much is that of cinder cars in the handling of the cinders to the cars when they are wet as well as unloading them afterwards. The value of hot water for boiler washing was emphasized and shown to be efficient and economical. It was also urged that facilities be increased in order to avoid the criticism for keeping engines at terminals an excessive length of time and this occurs especially in the winter time when the amount of power put on the division is apt to be very materially increased. The committee was also asked to make recommendations for the operation of a turntable especially in a cold climate as to what power had best be applied. Criticism was also made of the inadequacy of the steam supply usually supplied to the round houses.

TRAIN RESISTANCE AND TONNAGE RATING

The report was merely one of progress no data being given of any kind and in the discussion it was asked if the train resistance and tonnage rating committee had any record of tests to indicate the internal friction in pounds per ton of Mallet locomotives at different speeds. To which a member of the committee replied that this matter had not been considered in connection with the report and that the resistance so far considered has been for different weights and size of cars and different types of cars of the same weight and that the committee did not have any recent available matter on locomotive resistance.

Ole Hansen on Government Control.

It cannot be shown, from my experience, that the public utility that employs any large number of men, or where a large amount of capital is necessary, can or will function as efficiently as a publicly operated utility as a private corporation which has individual reward at the end of the day.

From my experience in traveling over this country, after the government has had the roads and operated them, I believe that it will take perhaps fifteen years to rehabilitate the railroads of this country.

I know whole systems where there is not a single train that even tries—that dares try—to make the slow schedule on which they are running.

I can show you abandoned and unrepaired cars, or cars in need of repairs, on the side tracks all over the West.

Now, it will take billions of dollars and it will take ten or fifteen years of time before our transportation system is in the condition to function with our growing industries.

It seems to me it should be the work of every honest man, whether he is in the utility business or whether he is just a man like myself, that has no particular interest to serve, to educate the public to the truth.

The truth is that the railroads have been starved. That is the truth.

The truth is that under government ownership their repairs have not been kept up.

The truth is that under government ownership railroad help is not as efficient. It is not.

It seems to me that the time has come to protect that great body of men and women who put their money in public utilities, and who during this war have had their entire capital cut in two, and you have never heard a murmur from them.

The man who invested $10,000 in a railroad bond seven or eight years ago, or five or six years ago, simply has $5,000, figuring on the meat and clothing and house rent basis.

We must see to it, if we are honorable men, that those men get a run for their money, or else we are thieves.

If we want to make the American government a kind of pickpocket, the way to do is just to confiscate these great properties throughout the country.

If after a time it becomes impossible for a utility enterprise that has honestly and conscientiously expended the public's money in creating or developing or building a gas plant or an electric plant or a street car plant—if the time comes that they cannot operate, it is impossible for them to get by—there is only one way; we must raise the rate so that they get by, or we must refund to them the money they put in the enterprise.

Of course, I know what these little spittoon philosophers in every town say about all corporations, but in the final analysis the corporations are owned by the great rank and file of the people, who have been thrifty enough to lay aside something for a rainy day, and I believe that every public man's work in this country is to see that those men get justice and at the same time see that the public gets adequate service, rendered at a fair price and compensatory remuneration to the satisfaction of all concerned.

Snap Shots—By the Wanderer

Echoes from the Convention

They didn't say much about it in public, but the air was filled with all sorts of prognostications pessimistic and otherwise as to how the labor situation was to be bettered. There were few, if any, complaints about high wages and short hours. These were accepted as existing conditions without an immediate prospect of lowering of the one or shortening of the other. But the real complaint, the one in the air, echoed here and there and everywhere, was that of the indifference of the man who worked in the shops, on the road, in the office. His lack of interest in what he did. His utter failure to realize or recognize his obligation to render a fair day's work for a fair day's pay. He seems to know of no responsibility to the public, his employer or himself. It seems everywhere to be a case of "*facilis decensus*": it is easy enough to descend into hell, but to return again, that is the trouble that is the labor. For this no one seems to have a solution other than the gradual return of the individual to a realization of his duties as a man and a citizen, and then, perhaps we will be able to climb again from Tartarean darkness to the open light of day.

"Oh wad some power the giftie gie us
To see oursel's as ithers see us."

It might be well for our complacency and do us good. It isn't quite mechanical this, nor of cars nor locomotives but of the convention and a conversation that is truly reported.

It was Saturday night on the 12th of June. The evening concert was over and the dancing had just begun. Dramatic personae: a bright American woman and a distinguished visiting foreigner.

The Lady: I suppose you have been asked it a million times and are quite tired of answering it, but really, what do you think of our country and this convention?

The Foreigner: Yes, I think I must have been asked it quite a million times, but to answer both, as a whole, in a single unqualified sentence, I can truly say they are truly wonderful and great, but if the question refers to details, then the answer must be made with qualifications.

The Lady: For instance?

The Foreigner: Well! This concert. It is an evidence of the lack of a general musical training among your people. Had there been such a gathering as this in Europe, where people were brought together from remote corners, such as, say, Billings, Montana, and the little towns of Iowa and Texas and Oklahoma the managers of the entertainment would have given them music such as they could not have heard at home. There would have been a real orchestra and the selections would have been of real merit, and they would have been given in a fitting manner not by an agglomeration of not very well conducted instruments with a noisy xylophone in front of the first violins, and drowning out all other sounds. The arrangement was not artistic and not as we would have done it. Nor would any conductor in all Europe have found it necessary to ask an audience not to talk during the rendition of a number, a thing only too common here and which emphasises what seems to us the failure of the mass of your people to appreciate music and show consideration for the few who do. You asked me and I have been frank.

The Lady: Then I don't suppose you like Jazz bands like this one?

The Foreigner: No, for such a racket will drive a music lover or a man to whom dancing is the emotional expression of the poetry of sound, to do one of two things; either in language of your cowboys to shoot up the band, or go home. As I cannot do the first, I must bid you good night.

On the whole the exhibition was voted a success both by the exhibitors and the visitors. But there was the inevitable fly in the ointment. The freight congestion did much to delay shipments, and there were many exasperating delays, but, to the visitor, these did not appear, for everything was spic and span on the opening morning and all traces of the previous preparation had been swept away. As to delayed shipments some of the exhibitors ran no risks but sent their goods by motor truck; some even making the shipment in that way from Pittsburgh, others from distances of from 150 to 200 miles. While many of the Philadelphia exhibits came in that way. But the big fly in the ointment, the one that raised the most disgust, was what was considered the exorbitant charges of the truckmen. It looks very much as though Atlantic City was overreaching itself. To charge $60.00 a load for hauling about four blocks and then pile pier charges on top of that was thought to be rather rubbing it in. News like that travels far and fast and already the Supply Men's Association is seriously considering making no exhibit at the street railway convention in October.

It was recalled that once upon a time these conventions were wont to meet in Saratoga, and the town finally came to the conclusion that it owned the whole liberal output and proceeded to boost prices and overcharge until the victim revolted and Saratoga lost the hen of the golden egg forever. The crowd will stand for much but the time comes when it will bolt. A group of men discussing the matter recalled how the charge of a certain hotel (whose proprietor had always been more or less grasping and obnoxious) of $5.00 an hour for the use of a ping pong board had done as much as anything to precipitate matters, and leave Saratoga in the lurch. So it may be that Atlantic City will lose tenfold the gains of the truckmen at $60.00 a load if there is no street railway exhibit in October.

It may or may not be that the exorbitant charges are the cause, but for the first time there appeared to be a general conjecturing as to the cost of the exhibition. Heretofore it has been the subject of casual mention only, but this time it seemed to be a metter of general interest and wonderment that so expensive an affair could be a paying investment. As to the total cost the estimates varied from one and a half to two and a half million dollars with no criticisms of the highest estimate. As a goodly portion of this outlay is left in Atlantic City it would be a veritable calamity for the place, as was frankly admitted by the mayor in his address of welcome, when he said that the convention was the most popular one that came to Atlantic City because it left the most money, and its members were the freest spenders. Frank certainly, and truthful, and in a way complimentary. But liberal spending, especially if it takes shape in tipping, does not always insure good service, as many ladies found to their cost in the insolence and demands of the chair pushers. But the signs of the times seem good when the crowd is beginning to count the cost.

Not a word was heard in criticism of the general appearance of the exhibits. Taste in arrangement and display characterized the whole, and since uniformity in signs and decorations have been enforced, no one seems to think that much further improvement can be made. Here and there a voice was raised against the too lavish display of plants on the ground that they partially obscured the exhibits. But the voice was usually a weak one, not at all insistent, and quite ready to acknowledge that the value of the added beauty more than compensated for the slight obscuring which might occur to the observing eye.

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The Convention of Section III.

Ever since its organization into the American Railway Master Mechanics' and the Master Car Builders' Association, what is now known as Section III, Mechanical of the American Railway Association, has had a steady and healthy growth. Each succeeding year has shown some improvement over its predecessors and its technical proceedings, in the minds of many engineers, easily rank first in value among those of all the other technical associations of the world.

The work of the convention of this year has proven no exception to the general rule of progressive excellence that it has established, and this holds both in the character of the technical papers presented and that of the range and scope of the exhibits. It would be impossible to do full justice to the Atlantic City gathering without printing the papers and reports in full and then making a detailed review of the exhibits from the boardwalk to the end of the pier.

Of recent years it has become the custum to limit the technical sessions to the morning hours of each of the six days on which they are held, allowing the afternoons and all of Saturday for an examination of the exhibits. This is an excellent working plan, for after three hours of attention to matters of a technical nature the limit of elasticity of an audience is nearly reached and it becomes unfair to a committee or to an individual to ask that a report or paper involving a great amount of work should be presented to a gathering suffering from brain fag brought on by its close attention to what had gone before.

Whether it is due to a whipping in or to the shorter hours, the fact remains that the little Greek temple at the end of the pier is usually filled to capacity throughout the whole session, and railroad men are not very plentiful among the exhibits.

But an early adjournment with an hour or so for lunch leaves a long afternoon for attention to the exhibits. And they certainly receive it.

There is too much for any one man to see and study it all, and the usual plan seems to be to go over it, and, to use the expression of one superintendent of motive power, "hit the high spots," or points of peculiar personal interest. Fortunately for the exhibitors, what may be the high spots for one man are the low for another, with the result that each, in the end, feels that he has received his due share of attention and appreciation.

There were however, a few exhibits that seemed to be picked out for general appreciation. A year ago one of the most notable among the exhibits was the single expansion Mallet locomotive exhibited by the Pennsylvania Railroad. This year a New York Central engine was shown, carrying a booster engine designed by one of its officers. This makes a driving wheel of the trailing truck wheel of engines of the Atlantic, Pacific or Mikado types, and yet it ceases to be a driver as soon as the speed increases to a point where it is desirable to shorten the cut-off. The group of connectors for automatically coupling the brake, steam and signal pipes attracted so much attention as to lead an unprejudiced lay observer to think that the railroads were really seriously considering the adoption of a device of this kind. And so the list and recapitulation might be extended indefinitely.

But when all is said and done, it is the convention proper, the technical sessions with their reports and papers that are the real thing, the cause and justification of it all.

That they really do justify the great assemblage would be granted by anyone who looks over the program printed in our May issue and the review of the first days' proceedings that appears in another column of this issue.

This year there are two individual papers which deserve especial attention. One is the exhaustive paper on "Snow Fighting," by Mr. Winterrowd, which is published in liberal abstract in another column, and in which the author reviews the general problem of snow removal in such a way that the reader has a clear idea of the actual technical problem involved as well as of the manner in which that problem has been solved. Mr. Winterrowd makes no claim that the last word has been said or the last line drawn in the designing of snow fighting appliances, but he does set the matter forth in such a way that he who wishes to improve upon the best methods now in use will have no excuse for wasting time on impracticable schemes or reopening old paths that are now overrun with the undergrowth of failure.

In his paper on the "Locomotive as an Investment," Mr. Basford shows his old finger marks with which we are all so familiar. Without accusing him of being an efficiency engineer, Mr. Basford has been for years the apostle of efficiency, which is, perhaps, a more efficient way of accomplishing the object that we all desire. Years ago he preached efficiency in the shop, and the proper training of apprentices, and the general interest that is now taken in the subject can be traced back to a paper by the same author before the same association years ago. And now he gets up in meeting and tells the railroads some wholesome, if not very palatable, truths about the way that they are neglecting to meet modern requirements. In the discussion it was frankly acknowledged that his arraignment was a true one and the members were advised to go home and sin no more.

It is beyond the scope of this review to so much as mention all the papers presented, but among those published in abstract in this issue there are two deserving of especial attention. They deserve this because they represent the ending and beginning of the consideration of two subjects of great economic interest to the railroads. They are the reports on mechanical stokers and feed-water heaters.

Years ago the association took a mild interest in some verbal reports on the work done by certain mechanical stokers that did strut their few hours on the railroad stage and then went the way to oblivion. There was no real need for a stoker in those days and the interest was perfunctory. Then the engines grew and grew until the stoker became first desirable and then a necessity. Officials paid attention to stoker talk. The requirements of a stoker were set forth. Its economy of operation was the subject of earnest inquiry. It was used, improved and improved again. Its use became so common as to be accepted without comment. It became relatively as efficient and reliable as any of the regular working parts of the locomotive. It ceased to be blamed for everything that happened on or off the right of way. It became a part of the machine like the injector or the sight-feed lubricator. And now it is discussed in that light. It is not perfect and never will be, and no one expects the impossible from it, and henceforth its novelty is gone and conjecture about it is of the past. Its interest as a novelty has ended.

And in its place we have for a novelty the feedwater heater. As years ago we had hopes for the stoker so now we have hopes for the feedwater heater. It is a lusty youth that has already given a good account of itself. We all take an interest and pat it on the back and say "go to." But neither the report nor its most firm believers are yet quite willing to claim that it has won its spurs and is ready to enter the tournament of working competition and meet all comers on their own terms. But many men are at work training this new aspirant for locomotive honors and are doing their best to hasten the day of its full acceptance into the family of locomotive appliances. So there we are. The great convention has come and gone, and one more volume has been added to that library of great achievements that has now occupied some fifty-odd years in the writing since its first little primer was given to the public in the late sixties of the last century.

Claims of the Railroad Executives.

After careful deliberation the railroad executives have made a formal application to the members of the Interstate Commerce Commission for a general increase in freight rates of not less than 30 per cent. They have decided not to ask for an increase of passenger fares. They rely upon an increase of freight rates to bring their net earnings up to the point allowed them by the new transportation law. The proposed increase in the Eastern freight rates is 30.4 per cent; in the Southern rate 30.9; and in the Western rate 23.7 per cent. This makes an average increase of about 28 per cent calculated to yield increased revenues of $1,017,000,000 a year. The total freight revenue of the railroads in 1919 was $3,653,928,000, and the total of all revenues was $5,230,981,000. The net income of the roads in 1919, adjusted to the present cost basis, was only $219,217,000, while the 6 per cent on investment allowed by the new law amounts to $1,236,994,000. The deficit is $1,017,776,000, which is sought to be made up by the proposed freight rate increase.

One salutary feature of the railroad problem should be mentioned. It is the changed attitude of the shippers' organizations at rate hearings before the Interstate Commerce Commission. Those bodies used to be, first, last and all the time, in favor of holding down freight rates. The experiences of the war seem to have greatly shaken their belief in the value of rock-bottom freight charges. Even in the early period of the war, before the United States entered it, the shippers had begun to see the light. Now the shippers know—know from their own bitter experience—that starved railroads cannot give good service. Now they know that bankrupt treasuries cannot buy rolling stock needed for existing lines and cannot borrow money to build needed new lines. Now they know that the costliest thing alike for the carriers and for the shippers, for the producers and for the consumers, is a run-down, inefficient, collapsing transportation system that cannot haul goods as the welfare of the nation requires them to be hauled. They have become more liberal-minded. They see that poor service is dear. The loss to the country through an impoverished railroad service is always likely to overbalance the saving in freight bills. Both shipper and consumer are better off if the carriers are operated efficiently and constant betterments are made possible by a little larger margin of return to the railroad.

The Beginning of Railroad Relief.

The Interstate Commerce Commission has provided some relief to the railroad executives by the appropriation of $125,000,000 of government funds for the purchase of new rolling stock. This is made immediately available by the appropriation of $300,000,000 made by Congress for the purpose. For the construction of new locomotives $50,000,000 will be set aside, and $75,000,000 for freight cars, preference being given for the immediate construction of 20,000 refrigerator cars. Preference will also be given for switching and freight locomotives. The distribution of the fund has already begun, and the effect will be felt by the time that the general movement of crops from the West will have begun.

By the time that this limited measure of relief has begun to be felt it is hoped, however, that the more stable relief of a raise of rates will have been granted by the Commission. It is remarkable that in view of the fact that while almost every country in the world has ungrudgingly in many instances more than doubled its transportation rates in view of the exigencies of the situation, the wealthiest country of them all has had to undergo a system of beggarly depreciation in needed material until a threatened national paralysis is almost upon us, and from which it may take, even under the wisest legislation, a long time to recover.

Improved Car Service.

The efforts that are being made by the Car Service Commission at Washington in combination with the car service committees are beyond all praise, and in spite of the difficulties to be overcome, the work of restoring the service to normal conditions is making better progress than might have been expected. As is well known, the war and the industrial developments following the war, produced abnormal operating conditions. Among other causes the wide dispersion of cars away from their home roads has reduced the repair work to a minimum. Box cars had become unduly concentrated in the East, causing an acute shortage of cars necessary for the transportation of grain in the West, where an undue accumulation of coal cars had occurred, causing a serious shortage of the output of coal in the East. Labor discontent aggravated the situation, but through it all the light of superior intelligence working towards a definite end has already manifested itself and the reports from many districts are of the most encouraging kind, and the former standards of efficiency bid fair to be surpassed in the near future.

Besides the Car Service Commission at Washington, there are twenty-nine local car service committees located at the chief intermediary transportation points throughout the country. The members of these committees have been carefully selected from among men of experience and if more are needed they will be forthcoming, and it may be relied that all will be done that human ingenuity can accomplish.

Safe Car Windows.

Throwing stones through the windows of passing trains is a favorite amusement of half-grown boys. It is no longer necessary to subject passengers to such dangers. As new passenger cars are built doubtless they will be glazed with the recently invented laminated, safety glass. This consists of two sheets of ordinary glass between which is interposed a thin sheet of pyroxylin plastic. Hydraulic pressure and the application of the proper degree of heat welds the glass and the pyroxylin sheet together in a solid unit. The pyroxylin binder prevents any scattering of fragments in the event of violent breakage of the glass.

Recently, in a test, a nickel jacketed revolver bullet, fired from a distance of seven feet, failed to penetrate a sheet of this laminated glass. The transparency of the glass is not appreciably reduced by the insertion of the plastic sheet. The use of laminated glass windows would reduce these dangers to a minimum. Car builders are unquestionably going to receive many specifications in the near future calling for this equipment.

Locomotive Headlight at the Chicago Convention.

A row of locomotive headlights of an obsolete arc type were arranged about the balcony of the huge Coliseum in Chicago during the Republican Convention, for the double purpose of illuminating the speaker's platform and securing motion pictures.

Air Brake Department

Questions and Answers

Locomotive Air Brake Inspection.

(*Continued from page* 181, *June,* 1920.)

1240. Q.—What is wrong if there is no air pressure in the signal system at the rear of the tender, the tender brake applied and the driver brake released?

A.—The brake cylinder pipe and signal pipe hose are cross-coupled between the engine and tender.

1241. Q.—What is generally wrong with an engine just out of the shop, when there is a heavy blow from the emergency exhaust port of the brake valve and all of the brake apparatus has been cleaned and tested?

A.—It is due to improper pipe connections about the brake valve or distributing valve.

1242. Q.—What pipes are usually found to be wrongly connected?

A.—The reducing valve pipe is connected to the independent brake valve bracket at the point the application cylinder or release pipe should be.

1243. Q.—Is any other wrong connection ever found?

A.—Sometimes the equalizing reservoir pipe and the application cylinder pipe are found to be crossed.

1244. Q.—What is the wrong pipe connection, when a heavy blow starts at the emergency exhaust port of the automatic brake valve, when the independent valve is placed in application position?

A.—The release pipe branch between the brake valves is connected at the independent brake valve bracket at the point the application cylinder pipe should be.

1245. Q.—What is meant by the H-6-E automatic brake valve?

A.—The brake valve which is used on locomotives that haul trains equipped with universal valves electrically operated.

1246. Q.—What is the difference between the H-6 and H-6 E brake valves?

A.—The only difference is in the rotary valve key and the rotary valve body.

1247. Q.—What is this difference?

A.—The key is longer and there is a drum containing electric contact points mounted in the valve body.

1248. Q.—Is there any difference whatever in the pneumatic operation between the valves?

A.—None whatever; all parts except those mentioned are standard for both valves.

1249. Q.—How are electric connections made in the drum when the brake valve handle is moved?

A.—Four contact fingers make suitable contacts on an insulated cylinder through which the rotary valve key passes.

1250. Q.—How many electric wires are attached to the drum?

A.—Four.

1251. Q.—What are they named, beginning at the top wire?

A.—The supply wire, the service magnet wire, the release magnet wire and the lower one in the emergency magnet wire.

1252. Q.—From the drum, where do these wires run?

A.—Into another cable line of 7 wires running from the pilot to the rear of the tender of the locomotive.

1253. Q.—What wires are connected when the knife switch in the cab is closed?

A.—The battery plus and the emergency switch wire.

1254. Q.—What wires run to the signal whistle magnet valve?

A.—The signal wire and the battery minus wire.

1255. Q.—Is there any current on these wires when the locomotive is in the engine house?

A.—No; the electric current is obtained from a car lighting battery box of one of the cars of the train.

1256. Q.—What is to first be done if it is necessary to take one of the brake valves apart for cleaning or repairs?

A.—The drum is to be opened by the door, which is held closed with a thumb screw, and the wires are to be disconnected.

1257. Q.—What must be done before any wire is disconnected?

A.—It must be marked to be absolutely certain that they will again be properly connected.

1258. Q.—How are the two lower wires, the release and emergency magnet wires disconnected?

A.—By slacking off the screws that fasten the wires to the binding posts or receptacles.

1259. Q.—How are the upper wires disconnected?

A.—The connections being in the back of the drum, there is a considerable amount of slack wire left in the drum, and these wires themselves have couplings in them.

1260. Q.—How is the point of coupling found?

A.—By locating the thickest part of the insulation where the wires will be found wrapped with tape about 8 inches from the attachment to the drum.

1261. Q.—How are the wires then separated?

A.—By uncoupling the small connectors in a similar way that air hose coupling is disconnected.

1262. Q.—How should these connectors be installed?

A.—With the guide pins the reverse on each wire to prevent the wrong couplings being made when again connecting the wires.

1263. Q.—Is this always doneé

A.—No; therefore the necessity of marking the wires before disconnecting.

1264. Q.—How is the valve taken apart and cleaned?

A.—In exactly the same manner as the H-6 brake valve; there, however, will be no handle lock and jam nut to be removed.

1265. Q.—What must be done after the lower wires are again fastened in place and the top ones coupled?

A.—The connectors are to be rewrapped with tape.

(*To be continued.*)

Train Handling.

(*Continued from page* 182, *June,* 1920.)

1274. Q.—Where is the electric current obtained for the operation of the electric pneumatic brake?

A.—Usually from the car lighting batteries of one of the cars of the train.

1275. Q.—What is to be done in connection with the electro pneumatic brake before the engine is coupled to the train?

A.—That the brake switch, located in the cab, is closed.

1276. Q.—What additional connection is there then between the cars, and tender and first car?

A.—A jumper connection for the electric line wires.

1277. Q.—How is the brake valve handled when a signal to test brakes is given?

A.—By making a 25 lb. brake pipe reduction and returning the valve handle to release position for a period corresponding to the air pump and main reservoir capacity and the length of the train, then to holding position.

1278. Q.—And when the signal to release is given?

A.—The brake valve handle is to be moved to running position to release the brakes.

1279. Q.—What if there are cars in the train not equipped with the electro pneumatic brake?

A.—Such cars would be placed on the rear end of the train, and by arrangement with the inspectors, two release signals would be given.

1280. Q.—How would the brake valve then be handled?

A.—With the usual 25 lb. brake pipe reduction and return to lap for a test of the brakes on the pneumatically operated cars.

1281. Q.—And when the signal to release is given?

A.—Move the handle to release and holding position.

1282. Q.—And after the inspectors have examined the electrically operated brakes, and given the second release signal?

A.—The brake valve is to be moved from holding to running position.

1283. Q.—What if the electric brakes release when the handle is placed in holding position?

A.—The electric brake is inoperative.

1284. Q.—What must then be done?

A.—If trouble cannot be located and repaired without delay, the train can proceed with the brakes being operated pneumatically.

1285. Q.—In addition to the battery wires, what are the three principal lines from the brake valve to the universal valves?

A.—The service magnet wire, the emergency magnet wire and the release magnet wire.

1286. Q.—What connection is made when the brake valve is placed in service position?

A.—The battery or supply line is connected with the service magnet line, and all service magnets on the universal valve brackets are energized.

1287. Q.—With what result?

A.—The armature is drawn down on the core, unseating the service magnet valve.

1288. Q.—And this does what?

A.—Opens the brake pipe to the brake cylinders at each universal valve.

1289. Q.—Through what check valve does brake pipe pressure pass to the brake cylinder?

A.—The electric service port check valve.

1290. Q.—What is its use?

A.—To prevent an escape of brake cylinder pressure if the brake pipe pressure is to be discharged to the atmosphere instead of into the brake cylinders.

1291. Q.—What occurs when the brake valve is returned to lap position?

A.—The service magnets are instantly de-energized and the magnet valve springs return the magnet valves to their seats.

1292. Q.—How is the brake valve handled for a service stop?

A.—It is placed in service position for the initial reduction specified, then the brake is applied as heavily as required for the stop, and the handle promptly moved to release and holding position.

1293. Q.—How does this affect the universal valves?

A.—The equalizing portions are moved to release position with the brake valve movement; while in holding position the brake pipe feed valve regulates the pressure in the brake pipe.

1294. Q.—What prevents the release of the brakes?

A.—The release magnet lines are connected with the battery wires in both release and holding position of the brake valve and this energizes the release magnets which hold the brake cylinder exhaust port closed.

1295. Q.—How is the brake valve then handled if the train is going to stop a trifle short of the point?

A.—Any desired amount may be graduated out of the brake cylinders by moving the brake valve from holding to running position and back to lap.

1296. Q.—And this alternately?

A.—Energizes and de-energizes the release magnets, producing a perfect graduation of release.

1297. Q.—And stopping a train is about as difficult operation as?

A.—Stopping a lone engine with the ET equipment.

1298. Q.—How is an electric emergency application made?

A.—By moving the brake valve handle to emergency position.

1299. Q.—And this energizes?

A.—The emergency magnets which discharge brake pipe pressure from the emergency piston chamber at a faster rate than at which quick action and quick action closing chamber pressure can escape to the atmosphere.

1300. Q.—What is the emergency switch piston for?

A.—For transmitting electric emergency if the brake pipe is opened at some other point than on the locomotive.

(To be continued.)

Car Brake Inspection.

(Continued from page 183, June, 1920.)

1214. Q.—What is located in this line?

A.—A switch and fuse box.

1215. Q.—After the engine is coupled and the jumper connection is in place, what must next be done?

A.—After the brake and signal hose have been connected and cocks opened in the usual manner, the switch at the battery box of the first car in the train must be closed.

1216. Q.—What about the switches in the fuse boxes of the other cars?

A.—All must be open.

1217. Q.—To what intent?

A.—That there is but one source of electrical energy employed.

1218. Q.—What wires lead to the electric position of the universal valve?

A.—The emergency switch, release, application, emergency and battery minus wires.

1219. Q.—After the battery switch is opened and the battery wires charged, what must the engineer do before the electric feature will operate?

A.—Close the knife switch in the cab.

1220. Q.—Connecting what?

A.—The battery and emergency switch wires.

1221. Q.—Where are the contacts made for the various wire lines for operating the brake?

A.—In a drum located at the top of the automatic brake valve of the locomotive.

1222. Q.—And closing the knife switch charges what?

A.—The emergency switch wire leading to the drum on the brake valve and throughout the train.

1223. Q.—In case of a defective switch or battery on the first car, what must be done?

A.—The battery switch on the second car of the train should be used.

1224. Q.—When the engineer is requested to apply brakes for test, what results when he places the brake valve in service position?

A.—The service and release wires are connected with the supply or emergency switch wire.

1225. Q.—And this?

A.—Energizes the service and release magnets of universal valve of each car in the train.

1226. Q.—With what result?

A.—That the armature of the magnets are pulled down on the core, opening the service magnet valve and closing the release magnet valve.

1227. Q.—Opening the service magnet valve does what?

A.—Permits brake pipe pressure to flow into the brake cylinder on each car not exceeding a service rate of brake pipe reduction.

1228. Q.—And the release magnet valve?

A.—Holds the brake cylinder exhaust port closed.

1229. Q.—And when the handle is returned to lap position?

A.—The service magnet is de-energized, the magnet valve is returned to its seat and the brake pipe reduction ceases.

1230. Q.—Is the handle returned to lap position if all cars have the electro pneumatic brakes?

A.—No, the handle is placed in release position, then to holding.

1231. Q.—What magnet remains energized in release and holding positions?

A.—The release magnet holding the brake cylinder exhaust ports closed.

1232. Q.—After the brakes have been examined and the signal to release given, what brake valve movement is made?

A.—From holding to running position.

1233. Q.—And this does what?

A.—De-energizes all release magnets.

1234. Q.—With what result?

A.—The magnet valve springs move the valves to their normal position, opening the brake cylinder exhaust ports, releasing the brakes.

1235. Q.—What if the brakes fail to remain applied after the engineer has applied them?

A.—He has either returned the valve

handle to running instead of holding position, otherwise the electric feature is inoperative.

1236. Q.—What if but one of the brakes releases during the test?

A.—It indicates that the release magnet or valve of that car is defective.

1237. Q.—Should the Engineer be notified of the fact?

A.—Yes.

1238. Q.—What could he do if two or more cars had defects of this kind?

A.—Handle the brake valve accordingly, and leave the handle on lap position until nearly ready to make a release.

1239. Q.—What could be wrong if all brakes applied during the test, but would not release back of a certain point in the train?

A.—It would indicate a closed angle cock.

(*To be continued.*)

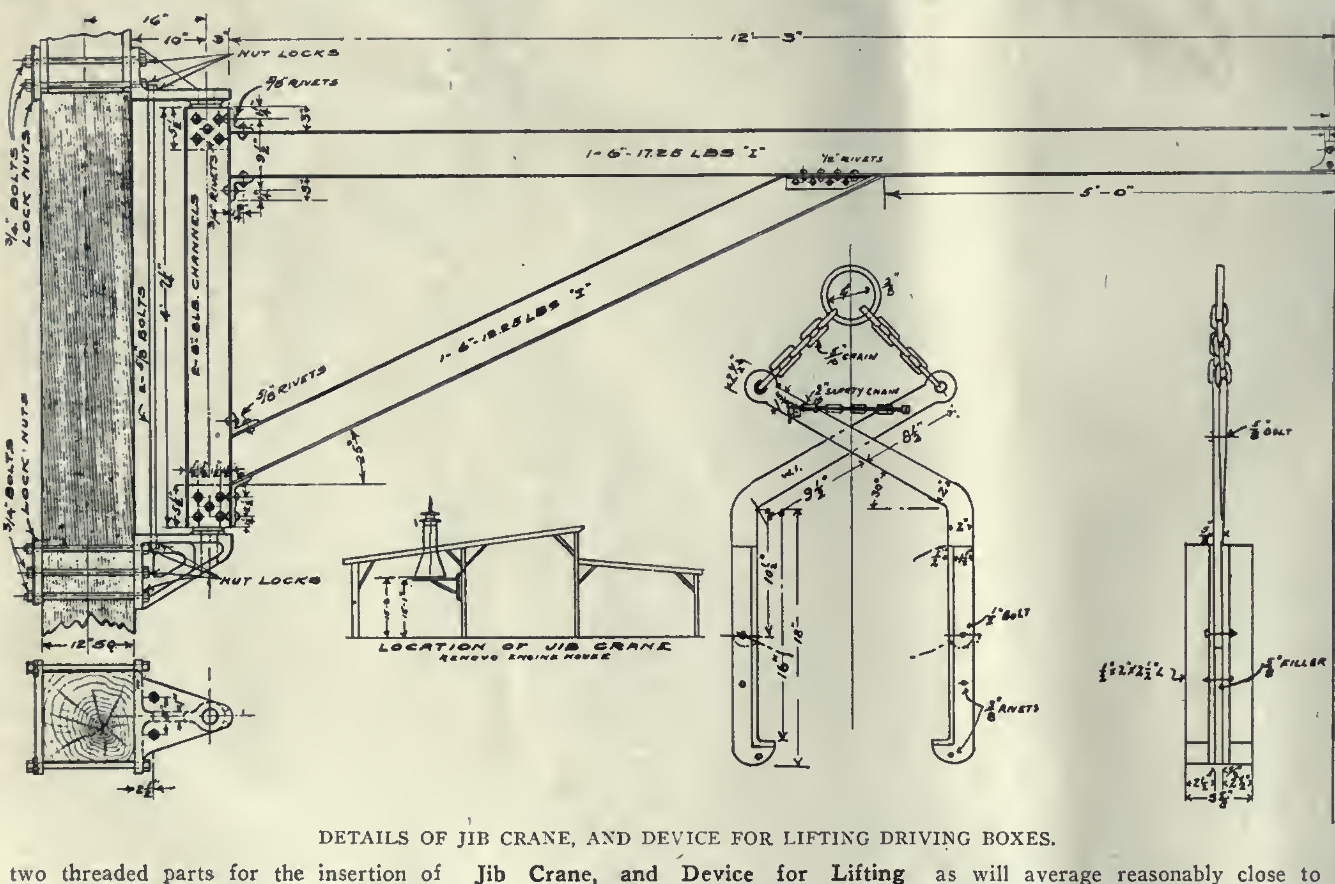
H-6 Brake Valve.

By B. R. Dixon, Belleville, N. J.

The elimination of the holding feature of the H-6 brake valve, which was referred to you in the report of the Air Brake Convention in the June issue of Railway and Locomotive Engineering, may be readily accomplished by observing that in the body of the valve there are two threaded parts for the insertion of the distributing valve release pipe, the one which is most convenient being used, and the other being closed by a plug. By removing the plug or by disconnecting the release pipe, commonly called the U-shaped pipe, then the holding feature will be eliminated. Any leakage in the release pipe between the distributing valve and the independent valve causes a loss of "slow application" and "lap" position of the independent valve.

The blowing down of the application cylinder and chamber pressure gradually, as stated in the report, by slacking the coupling in the release pipe, will not get rid of the pressure quick enough to avoid a "run in" when making a release with a passenger train.

On this division if an engineer is assigned to an engine with the holding feature still intact, as a rule, the first thing that he does is to eliminate it in the manner above specified. When this practice was first started a few years ago we disconnected the U-shaped pipe, and on arrival at the inspection pit the air brake inspector always coupled it up again. A few of the men better informed on the flow of the air removed the plug, and as the inspector had not an unlimited supply of plugs to make a replacement the plugs are all missing and will likely never be replaced. Personally I fail to see any benefit in the holding feature except in handling a train equipped with the universal control valve having the electric feature, then the holding feature is most essential.



DETAILS OF JIB CRANE, AND DEVICE FOR LIFTING DRIVING BOXES.

Jib Crane, and Device for Lifting Driving Boxes.

By A. C. Clarke, Pittsburg, Pa.

The chief accompanying drawing shows a 2,000 lbs. capacity jib crane, securely attached to a wooden post for engine house service. The supporting posts of engine houses as shown in the location part of plan are, of course, between the tracks, and will naturally serve both adjacent tracks for lifting front ends, bumper castings, bumpers or end sills, and front end doors, providing that the engines can be conveniently located, and the crane can also be used for lifting air pumps by swinging it back, there being space for it to swing over engine smoke stack and below engine house smoke jack. The jib is made of 1 ft. 6 ins. I beam, weighing 17¼ lbs. per foot, and is 12 ft. 3 ins. in length. The brace is composed of two I beams weighing 8 lbs. per foot. These channels are riveted together, and between them at top and bottom is a casting with a boss 2 ins. in diameter and extends downward at the bottom and upward at the top, resting in and turning in 2 1-16 in. holes, the castings being securely bolted to plates attached to the post as shown. Any suitable trolley of ample capacity will serve, and safety pieces attached to the jib are added to prevent trolley from running off the end of the jib, having approximately a travel of about five feet.

The annexed drawing shows the details of a device for lifting driving boxes vertically. The width of the enclasping parts may be made of such dimensions as will average reasonably close to the range of the boxes to be lifted. The tongs parts as shown are of ⅝ in. by 2 ins. iron, while the lifting hooks are of ½ in. by 1½ ins. by 2½ ins. angle iron. The tongs extend only down to about the middle of the lifting pieces and are fastened to the tongs by a ½ in. bolt on which the lifters are swung. Below the tongs part a ⅝ in. filler is provided and securely riveted to the angle irons. A ⅝ in. bolt is provided as a pinion for the tongs, and 5/16 in. chains are used, fastened or linked on to the lifting ring. The action in lifting transmits the motion to the tongs and tends to close them on the box. A safety feature is added and secured by an eye bolt at one end and chain over a hook at the other end, so that when the device is placed in operation on a driving box an accident is practically impossible, as the tongs cannot open until the safety chain is released. The device is easily constructed and reliable in operation.

Are Engineers or Machinists the Best Locomotive Inspectors?

In the old days the locomotive inspector was considered a pension job for some old employee. Things have changed somewhat and men are required for this post of inspection who are thoroughly trained for the position. The job has ceased to be a sinecure and the locomotive inspector today must understand the modern locomotive from the pilot to the back coupling on the tank. The question often arises,—who makes the most efficient inspector? Some say the machinist, others say the engineer. Some think because the machinist built the machine and knows every part, he is best fitted to inspect it. Some say it is the engineer because he runs the engine and knows where to look for defects, and he also has a better chance from observation and from becoming familiar with the engine by handling it day after day.

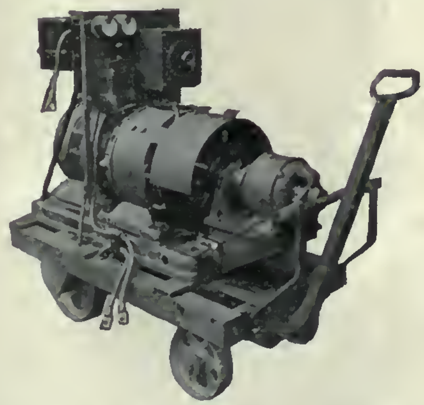
My opinion is that the engineer is the best qualified for the reasons just stated. A machinist's hobby is, naturally, machinery. In his round of inspection he will pay more attention to the condition of the valve motion than any other part of the engine, although this part is seldom out of order, and when it does become faulty it gives indication to the engineer very quickly by its irregular "breathing" as we call it. If the valve gear of a locomotive becomes disarranged while on the road, the engineer quickly detaches it, and takes steps to discover the trouble, and, if at all possible, apply a remedy.

The inspection of the locomotive at present calls for inspection by more than one man. There is what is called inspection above the running board, and then below the running board, besides cab inspection for steam leaks, boiler inspection, front end inspection, and in brief all construction work, and in this regard there never has been a time when these inspections have been made so thorough as they are made today on the modern locomotive. J. E. S.

Single-Operator Electric-Welding Outfit.

The illustration shows a reproduction of a photograph of a single-operator electric-welding equipment manufactured by the Westinghouse Electric & Manufacturing Company, and is claimed to be exceptionally efficient because the generator operates at arc voltage and no resistance is used in circuit with the arc. The necessity for providing automatic moving devices such as relays and solenoid control resisters are eliminated. There are 21 steps provided, from 50 to 225 amperes, giving a current regulation of less than 9 amperes per step, making it much easier for a welder to do vertical or overhead work necessary in railroad shops.

For portable service, the motor generator set with the control panel is mounted on a fabricated steel truck, equipped with roller bearing wheels, and is easily hauled about the shop or yards



TYPE OF SINGLE-OPERATOR ELECTRIC WELDING OUTFIT

by one man. The suitable plugs and receptacles for three-phase, three-wire or two-phase four-wire, direct or alternating motors allow the set to be quickly and conveniently connected to the supply circuit at any desired point. Only one plug is desired for the motor but the number of receptacles required depends upon the number of points at which it is desired to do the welding work. These plugs and receptacles are supplied on special orders.

The panel is made up of a single section upon which are mounted indicating instruments, protective apparatus and switches for adjusting the welding current. If additional circuits are required it is necessary to use separate outlet panels.

Each outlet panel consists of slate panel on which is mounted a circuit breaker, line switch and necessary single pole resistance adjusting switches for regulating the heat at the arc by varying the amount of current supplied. These outlet panels may be supplied for either metal or graphic electrode welding or both and may be operated simultaneously and independently of each other. The only limit being the capacity of the generator. A metal or graphic electrode holder is supplied with each welding panel, according to the work for which the panel is designed. The holders are of light weight, are well balanced and are designed so that they may be used continuously without overheating.

This portable equipment has been found wherever tried to be admirably adapted for repairs of the lighter kind that are constantly being found necessary in the exigencies of railroad service.

Air-Dried Peat.

At a recent meeting in Toronto a report was presented showing that the simple process of excavation, maceration and spreading peat allowing the sun to do the drying and curing of the peat, produced the best results. The excavated peat contains about 88 per cent moisture, and none of this water need be removed mechanically. The peat is spread on the surface of the ground, usually on a part of the bog which has been cleared and drained. The drying and curing takes from two to four weeks to complete. Towards the end of this time the peat is turned over, and a few days later is coned or stacked in hollow piles, and in a short time the peat is ready for marketing.

Train Speeds in Europe.

The European railway schedules are not yet quite up to the pre-war figures. Before the war the Northern Railway of France had an express running from Paris to St. Quentin, 95.7 miles in 94 minutes. The North Eastern of England was scheduled to cover the 44.3 miles from Darlington to York in 43 minutes, while the Great Central Railway express from Marylebone between Rugby and Leicester ran at a rate of 61.3 miles per hour.

Domestic Exports from the United States by Countries, During April, 1920.

Steam Locomotives.

Countries	Number	Dollars
Poland and Danzig	42	1,960,870
Italy	55	578,000
Canada	5	41,900
Mexico	2	21,700
Jamaica	3	106,770
Cuba	5	72,850
French West Indies	1	9,205
Brazil	11	334,000
Colombia	1	43,975
Peru	5	120,410
China	8	486,800
Kwantung	3	127,755
Philippine Islands	9	180,511
British South Africa	7	364,990
Total	157	4,449,736

A Handsome British Locomotive

By W. PARKER, President Railway Club, London, England

In British locomotive building it is by no means infrequent to find the designer and builder combining, in the same machine, the greatest utility with the utmost prepossessing appearance. Mr. J. G. Robinson, the chief mechanical engineer of the Great Central Railway, is responsible for some of the most successful, and at the same time, some of the smartest looking locomotives in the British Isles.

Mr. Robinson has just put into service a new 4—4—0 Express locomotive, named "Butler-Henderson," that is attracting considerable attention. It is the first of a series of engines, substantially the same as those known as the "Director" class, the first of which came out of the famous Great Central Railway Gorton Works in Lancashire, on August 16, 1913, but including certain improvements and changes. These "Director" class engines have rendered excellent service on the London-Manchester express trains of the Great Central Railway, and they are greatly admired and appreciated by the traveling public. American visitors to England who travel to Helmdon station, Great Central Railway, *en route* to Sulgrave, the ancestral home of the Washingtons, should not fail to keep a lookout for these very fine machines at work on the Manchester service.

Diameter of the driving-wheels of the "Butler-Henderson" is 6 ft. 9 in.; cylinders are 20 in. diameter; stroke 26 in.; distribution of steam is by means of 10 in. diam. piston valves arranged for inside steam admission. These valves are placed over the cylinders and are driven by Stephenson link motion through rocking shafts. The piston valves are of the "Robinson" type, and are fitted with pressure release rings. The boiler has a maximum diameter of 5 ft. 3 in. and the barrel is 12 ft. 3 in. long; the firebox is of the "Belpaire" type and is 8 ft. 6 in. long outside. The locomotive is fitted with a "Robinson" type superheater having twenty-four short return loop elements, the ends of the element being expanded directly into the header; circulating and header discharge valves are fitted. Safety valves of "Ross" type are employed. Cylinders, steam-chests and also the driving axle-boxes are lubricated by means of the "Intensifore" lubricator.

The enclosed cab, with extended roof is a new development on the Great Central Railway, and it is very commodious and well fitted up. The windows at the sides are of the sliding pattern.

The engine's main frames are parallel from end to end, no reduction being made in the distance between them forward of the motion plate. Both pairs of bogie wheels consequently have to run beneath the frame plates on sharp curves, and the main frame plates are suitably shaped to allow for this. The bogie has a total side play of 5½ in., controlled by double-laminated springs. This large amount of side play enables the locomotive readily to pass through curves of 5 chains radius.

A steam brake controlled by means of a vacuum brake, the vacuum fittings consisting of a 25/20 mm. "Dreadnought" ejector is used.

Other dimensions are: Working pressure, 180 lb. per sq. in. Heating surface: Firebox outside, 155 sq. ft.; large tubes, 416 sq. ft.; small tubes, 972 sq. ft.; superheater, inside, 209 sq. ft.; total, 1,752 sq. ft. Grate area, 26 sq. ft.

The locomotive develops a tractive force at 85 per cent. of the boiler pressure of 19,385 lb. Adhesion weight is 39 tons 16 cwt. on a coupled wheelbase of 10 ft. In working order the engine weighs 61 tons 3 cwt. without tender. The latter is of the standard Great Central six-wheeled type having a capacity for 4,000 gallons of water and 6 tons of coal. The standard Great Central water pick-up apparatus is carried.

Mr. J. G. Robinson, the Great Central Railway Chief Mechanical Engineer, served his apprenticeship on the Great Western Railway, but had experience in Ireland before going to his present post at Gorton. To-day he is generally considered one of the most progressive and successful locomotive engineers in Europe and his name is closely associated with the superheater he invented and with which the locomotive illustrated is fitted.

4-4-0 TYPE OF LOCOMOTIVE, GREAT CENTRAL RAILWAY OF ENGLAND

Pulverized Fuel.

It is claimed that the economy secured by using pulverized fuel in stationary boilers instead of hand-fired coal is not so great, in comparison, as that obtained by its use in locomotives. This is due to the fact that stationary plants can be fitted with the best mechanical stokers. There is an advantage of from two to three per cent. in combustion efficiency in favor of pulverized coal. There are also a number of localities in which pulverized coal has considerable economic advantage over higher priced inspected coal.

Painting Iron Smoke Stacks.

Experience has shown that although there are a fair number of heat-resisting paints on sale, it is doubtful whether for general use the old oil and lampblack paint is not as good as any, where the heat does not exceed about 600 deg. F. Possibly, however, if graphite is used in place of lampblack the result will be better if the paint is well rubbed in with a somewhat stiff brush, as in itself graphite is a good protective for iron when well attached to the surface. There are specially made graphite paints for hot surfaces, but it often happens that these are not available when wanted; while in most places graphite and lampblack.

Electrical Department

Electric Locomotive Control

We have discussed the electric locomotive from many sides, its advantages, its construction, etc., but we have not considered the various methods used in accelerating electric locomotives and the comparison of the energy losses by the different methods.

In locomotive operation it is very necessary to have extremely smooth acceleration from start to maximum speed where heavy trains are handled. The longer the train the more important it is to have smooth acceleration, otherwise surges will result and serious damage to the couplers and drawbars will follow.

The electrical design of the locomotive will depend on the system of electrification with which it is to be used. The systems may be classified under two headings:

1. Direct Current
2. Alternating Current.

We will first consider the Direct Current Locomotive Control.

In electric cars or trains it is at times very noticeable that there is a variation in the operation as far as smoothness is concerned. The trolley car is far from smooth operation, the acceleration depending wholly on the manner in which the motorman manipulates the controller handle. If he uses care, fairly smooth operation will result, otherwise the acceleration may be too rapid and jerky. The acceleration of the street car is entirely in the hands of the motorman, as so it is with the locomotive. The master controller of the electric locomotive can be considered as the throttle, whereby the engineer regulates the amount of power to the motors and thus the speed. The control is of course more elaborate, but the same fundamental principles are used.

There have been many changes in the arrangement of resistance and motors during the past several years of operation. There are many schemes of connections, all of which are feasible, but some of which have certain advantages. These various schemes will be discussed so that the motor and resistance combinations will be understood. Not only are there different resistance arrangements, but there are different methods used in combining the motors in the different combinations. Subway and elevated trains use automatic features so that the rate of acceleration does not depend on the movement of the master controller step by step. While some of these trains operate very smoothly throughout the entire range of the control steps, other trains of a different and older type do not do so, but are more or less jerky. The train will operate smoothly up to say, 10 to 15 miles per hour, there will be a moment of no acceleration, or perhaps a retardation and then the train will pick up rapidly again. This slacking off in speed and then the sudden pick up is very noticeable. While it is possible to operate this way with the elevated train, it would be impossible to use this arrangement with the electric locomotive on account of the damage caused by the surge.

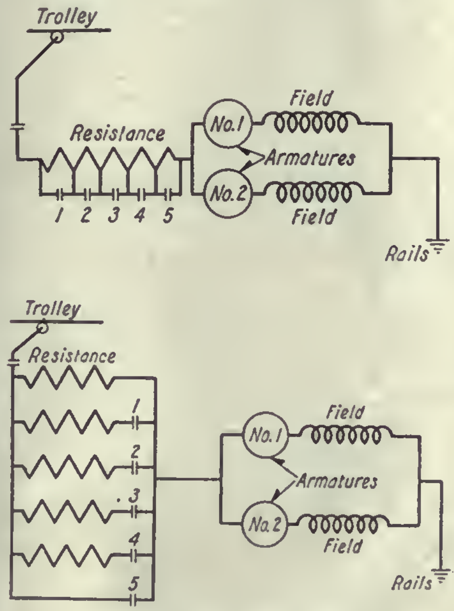


FIG. 1—SERIES AND PARALLEL STARTING RESISTANCE METHOD.

The reason for this variation is due to the method used in changing the motor combinations so as to increase the speed.

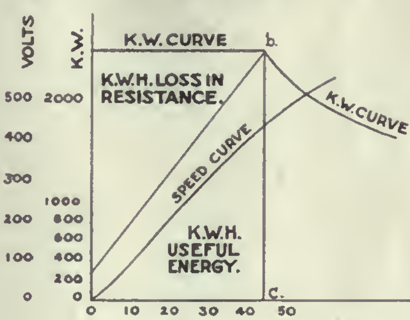


FIG. 2—ENERGY RESISTANCE LOSS.

The latest method, and one that is necessary for locomotive operation, is known as the Bridging Method. The other methods are known as the Shunting Method and the Open Circuit Method.

Full trolley voltage cannot be applied directly to the motors at standstill on account of the enormous current which would flow. Great damage both electrically and mechanically would result. The motor when standing still offers only its ohmic resistance to the flow of current, so that sufficient resistance must be placed in series with the motors to give the proper starting current. The resistance absorbs in the first point approximately 90% of the voltage. Cutting out the resistance step by step increases the voltage at the motor terminals until full voltage is obtained.

There are several ways of connecting in the resistance. The easiest way is to connect the two motors permanently in the full speed position and then provide sufficient resistance to keep the first current rush down to a safe value. When all the resistance is cut out the motors are in the high speed combination. This arrangement is known as rheostatic control and the resistance may be connected in three ways, namely series, parallel and a combination of the two. With the series resistance all of the resistance in the circuit is in series with the motors and it is gradually short-circuited by sections until the motors are connected across the full trolley voltage. The switches are all open at start, and are closed consecutively.

With the parallel resistance arrangement only a part of the resistance in circuit at start. Additional resistance is connected in the circuit in multiple by steps and on the last control step the resistance is short-circuited. Adding a resistance in parallel makes the combined resistance less, so that the voltage to the motors and hence the current, is increased. This is according to the law of parallel resistances. Assume we have individual resistances r_1, r_2, r_3, etc., and the R will represent the joint resistance when in parallel. Then according to the law

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} = \frac{r_2 + r_1}{r_1 r_2} \text{ or}$$

$$R = \frac{r_1 r_2}{r_1 + r_2}$$

The same rule is followed for a third step.

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} = \frac{r_2 r_3 + r_1 r_3 + r_1 r_2}{r_1 r_2 r_3}$$

$$R = \frac{r_1 r_2 r_3}{r_2 r_3 + r_1 r_3 + r_1 r_2}$$

The arrangement of the rheostatic control is shown by Fig. 1. Smooth operation is obtained with the above arrangements but there is a decided objection due to the arrangements not being the most economical. With the motors connected permanently in parallel there is considerable power lost in the resistance. Economy can be obtained by connecting the motors in combinations. Less resistance is required and there is less loss in the resistance.

The amount of energy loss is shown by Fig. 2. The figure is based on an electric locomotive equipped with four motors to operate on a third rail at 650 volts. It will require 1,000 amps per motor to start up this locomotive coupled to a certain train, and accelerating it up to a certain speed (where all the resistance is cut out) in 45 seconds.

With each motor taking 1,000 amps at 650 volts the power from the line is (4 x 1,000) x 650 = 2,600 K. W. This number of kilowatts is taken during the straight line acceleration, and is represented by the line *ab*. Forty-five seconds has elapsed so that the energy used is shown graphically by the area *o a b c*, and is 2,600 K. W. x 45 sec. = 117,000 K. W. seconds or

$$\frac{17{,}000}{3{,}600 \text{ (seconds per hr.)}} = 32.5 \text{ K. W. H.}$$

The energy lost in the resistance depends on the product of the current and the volts lost in the resistance. The volts lost is the difference between the line volts and the motor volts. A certain voltage is necessary to start the motor and is assumed as 10% of the line voltage so that in our present problem it is 65 volts. The kilowatts taken by the motors is then

$$\frac{65 \times 4{,}000}{1{,}000} = 260 \text{ kw. and}$$

this value locates point X. After 45 seconds all resistance is out, so that the line *xb* represents the energy lost in the resistance. The area below the line represents the useful energy absorbed by the motor. As 10% of the line voltage is used at the start, 90% will be lost in the resistance at start. Since *xb* is a straight line the average volts will be one-half of 90, or 45% of 650, which is 292.5 volts. The energy loss is therefore 292.5 x 4,000 x 45 ÷ by 3,600 x 1,000 = 14.6 K.W.H.

Details of Parts of the Pacific Type Locomotive as Shown in Our Chart, No. 12

Spring Suspension of Engine Frame.

The illustration of the parts of the chart of the Pacific locomotive, presented herewith, shows the arrangement of the spring suspension of the main frame. The arrangements of the suspension of the front and rear trucks were shown in the issues of January and March, 1920, respectively, and will only be indicated in this place.

In the case of the main frame the parts lying below the spring suspension are the wheels, axles, driving boxes and driving spring saddles and stirrups.

Taking up the whole structure as shown in this illustration, we first have the frame. This is usually a steel casting at the present time, though formerly it was invariably an iron forging. It is formed of an upper rail (1) and lower rail (2), with pedestal legs (3 and 4), a front slab section (5), to which the cylinders are bolted, and a rear slab section (6) upon which the firebox of the boiler rests and which, in turn, is carried by an equalizer connecting the main spring suspension with that of the rear truck.

For a Pacific locomotive there are three sets of pedestals for the front (7), main (8) and rear (9) driving boxes, respectively. These driving boxes are made up of two pieces, the box proper (7, 8 and 9), and a driving box brass (10). These are sometimes called crown brasses. The box itself may be of cast iron or cast steel, and the fit for the brasses cut out, usually on a slotting machine, to a semi-circular form and the brass pressed into place by hydraulic pressure. The lower portion of the box is fitted with a cellar (11), which is merely a box of cast iron having its upper portion curved to come close to the axle (13). It is fitted with oil and waste packed in so as to be in contact with the axle journal and is held up in place by the driving box axle pin (12).

The frame pedestals are braced and prevented from spreading under the thrusts of the axle boxes by the pedestal tie bars (14). These bars are first fitted to bear against the pedestal tie bar lugs (15) and then bolted to the frame by the pedestal tie bar bolts (16).

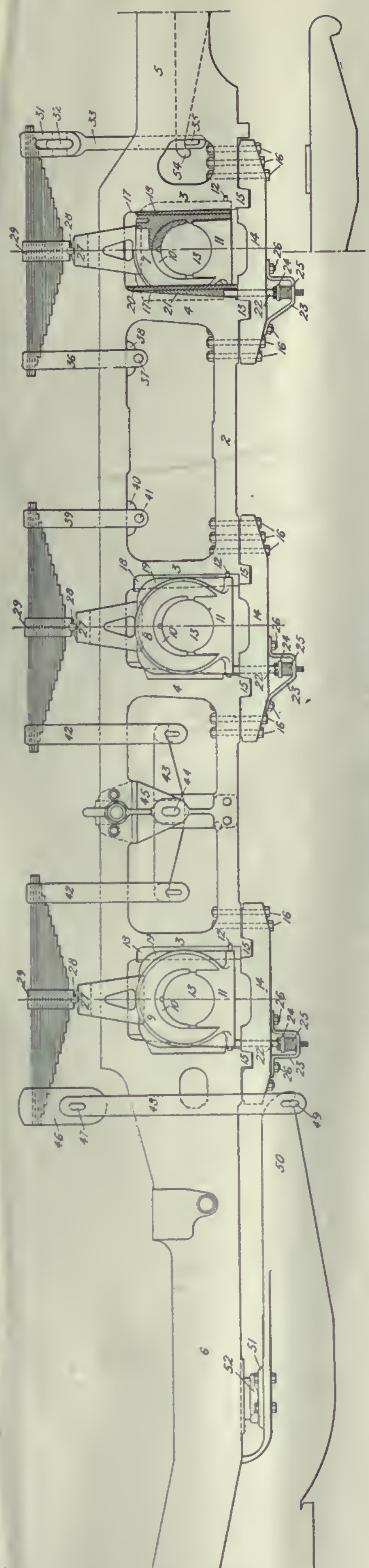
The inner faces of the pedestal legs are protected against the wear that would be occasioned by the up and down movement of the driving boxes by a set of shoes and wedges. It will be noticed that the inner faces of the pedestal legs (17) are not vertical but are inclined so that the distance between them is greater at the bottom than at the top. To the front leg a shoe (18) is rigidly fastened. This shoe is of a U shape in horizontal section, the inner side and bottom fitting against the leg of the pedestal and the outside planed to go between the front flanges (19) of the driving box. The rear pedestal leg is protected by a similar shoe (20), called an adjusting wedge, which bears against the driving box, but which is made adjustable so as to take up any wear that may occur by a floating wedge (21) placed between it and the face of the rear pedestal leg. There are a number of designs of this shoe and wedge. Usually they are combined in a single casting, but in the one shown they are in two pieces and are known as the Franklin automatic adjustable driving box wedge parts and are automatically adjustable. That is to say the wedge is automatically raised so as to push the shoe against the driving box and thus take up any wear that may occur.

This is accomplished in this case by means of the adjustable wedge bolt (22) which is attached to the wedge and extends down through the pedestal tie bar and the Franklin adjustable driving box wedge spring bracket (23). The bolt is threaded at its lower end and carries a spring cap (24). This is used to compress the spring (25). This spring is thus under compression and exerts a constant upward pressure against the bolt and, through it on the adjustable wedge, tending to force the latter upward between the face of the pedestal leg and the shoe, thus taking up all lost motion of the axle boxes due to wear. The spring bracket is held to the pedestal tie bar by the studs (26).

Turning now to the top of the driving box, it will be found to be fitted with a pocket on either side of the frame for the reception of the two legs of the spring stirrup or saddle (27). This is usually a steel casting and spans the frame. On its top is the driving spring roll (28) on which the spring band (29) rests, and on which it is free to rock with the movement of the semi-elliptic driving spring (30), as it is compressed or relaxed under the influence of the working of the load.

We now come to the spring suspension proper.

Starting at the front, the end of the spring of the leading driving wheel is spanned by a short spring suspension link (31), which carries the end of the cross equalizer (32). This equalizer runs across the engine from side to side, and is carried at each end in the manner here described. This cross equalizer is a heavy forging or steel casting, and has a driver and truck equalizer hanger (33) sus-



DETAILS OF SPRING SUSPENSION OF ENGINE FRAME.

pended from its center. The lower end spans the back end of the driver and truck equalizer (34), which it supports by means of the driver and truck equalizer hanger key (35). This equalizer has a bearing on a pin beneath the cylinder saddle, while its forward end rests on the truck.

The back end of the front spring carries the spring hanger (36), which spans the frame and carries it by means of the spring hanger pin (37), which carries the frame through the spring hanger spring seat (38) attached to the bottom of the top rail of the frame.

Thus there is an equalization or a distribution of the weight of the front end of the engine, between the front driving wheel springs and those of the front truck.

In the case of the spring suspension of the rear end of the engine we find the front end of the main driving spring attached to the frame by the means of a hanger (39) and pin (40) and seat (41), which are the exact duplicates of the hanger, pin and seat (36, 37 and 38).

From the back end of the main driving spring and the front end of the rear driving spring, there are two similar spring and equalizer hangers (42) which carry the two ends of the equalizer (43), respectively. This equalizer carries a portion of the frame between the main and rear driving wheels by means of the equalizer key (44), which has a bearing in the equalizer fulcrum casting (45), which is bolted to and between the top and bottom rails of the frame.

From back end of the rear driver spring, a combination of link (46), link pin (47), spring hanger (48) and spring hanger key (49), support the forward end of the trailing truck and driver equalizer (50). This equalizer forms a portion of the trailing truck as illustrated in our issue for March, 1920, and, as there described, carries the rear end of the engine frame through the fulcrum socket bracket (51) and the fulcrum ball (52).

Thus, as the equalization of the spring support at the front end of the engine causes the front driver and front truck springs to act in unison, so that at the rear it produces a similar unity of action between the main and rear driving springs and those of the trailing truck.

At the back end, however, the springs on the two sides of the engine are allowed to act independently of each other, while, at the front they are tied together through the cross equalizer (32). This, in a final analysis, resolves itself into a three-point support which is characteristic of American locomotive construction, and is the feature which gives to the type its extraordinary flexibility of action and freedom from liability to serious fracture.

The following is the list of parts.condom from liability to serious fracture or breakage.

List of Parts.

1. Upper rail of frame.
2. Lower rail of frame.
3. Front leg of pedestal.
4. Back leg of pedestal.
5. Front slab section.
6. Rear slab section.
7. Front driving box.
8. Main driving box.
9. Rear driving box.
10. Driving box brass.
11. Driving box cellar.
12. Driving box cellar pin.
13. Driving axle.
14. Pedestal tie bar.
15. Pedestal tie bar lugs.
16. Pedestal tie bar bolts.
17. Inner face of pedestal legs.
18. Front pedestal shoe.
19. Driving box front flange.
20. Franklin automatic adjusting wedge.
21. Franklin automatic floating wedge.
22. Franklin automatic driving box wedge bolt.
23. Franklin automatic adjustable wedge spring bracket.
24. Franklin automatic adjustable wedge spring cap.
25. Franklin automatic adjustable wedge spring.
26. Franklin automatic adjustable wedge spring bracket stud.
27 Driving spring stirrup.
28. Driving spring roller.
29. Driving spring band.
30. Driving spring.
31. Spring suspension link.
32. Cross equalizer.
33. Driver and truck equalizer hanger.
34. Driver and truck equalizer.
35. Driver and truck equalizer hanger key.
36. Front driving spring hanger.
37. Spring hanger pin.
38. Spring hanger pin seat.
39. Spring driving spring front hanger.
40. Main driving spring front hanger pin.
41. Main driving spring front hanger pin seat.
42. Driving spring and equalizer hanger.
43. Spring equalizer.
44. Spring equalizer key.
45. Equalizer fulcrum casting.
46. Rear driver spring link.
47. Rear driver spring link pin.
48. Rear driver spring back hanger.
49. Rear driver spring back hanger key.
50. Trailing truck and driver equalizer.
51. Equalizer fulcrum socket bracket.
52. Equalizer fulcrum ball.

Items of Personal Interest

George Goldsmith has been appointed shop superintendent of the Erie at Buffalo, N. Y.

G. W. Bichlmeir has been appointed purchasing agent of the Kansas City Southern, succeeding W. S. Atkinson.

C. I. Walker has been appointed master car repairer at the Los Angeles, Cal., general shops of the Southern Pacific.

M. G. Orr has been appointed roundhouse foreman of the Rock Island at Herington, Kans., succeeding C. Wittel, promoted.

John M. Kerr, road foreman Canadian National railways, has been appointed assistant master mechanic, with office at Joliette, Que.

A. T. Lohman has been appointed master mechanic of the Santa Fe, with office at Cleburne, Texas, succeeding J. E. Symons, resigned.

F. D. Buckley has been appointed general foreman of the Rock Island shops at El Reno, Okla., succeeding G. W. Heyman, transferred.

W. A. Summerhays, assistant purchasing agent of the Illinois Central, has been appointed purchasing agent, with headquarters at Chicago, Ill.

James Davis has been appointed road foreman of engines on the Southern Pacific, with headquarters at Sparks, Nev., succeeding S. A. Canady.

H. G. Becker, general foreman of the Delaware & Hudson at Colonie, N. Y., has been appointed shop superintendent, succeeding G. S. Edmonds.

Louis J. Alerding, traveling storekeeper for the Chicago & Eastern Illinois, has been appointed general storekeeper, with headquarters at Danville, Ill.

Robert Garey, round house foreman on the Union Pacific at Cheyenne, Wyo., has been appointed safety inspector at Cheyenne and Laramie, Wyo.

Vern C. Randolph has been appointed general supervisor of locomotive operation of the Hornell region of the Erie, with headquarters at Hornell, N. Y.

C. G. Juneau, general supervisor of the freight car department of the Chicago, Milwaukee & St. Paul, has been appointed master car builder, succeeding L. K. Sillcox.

C. F. Needham has been appointed assistant to the general superintendent of motive power and car department of the Grand Trunk, with headquarters at Montreal, Que.

Harry Tatum, who has recently returned from military service in Russia, has been appointed general roundhouse foreman of the Rock Island at Inner Grove, Minn.

Glenn A. Allen, supervisor of locomotive operation of the Erie at Susquehanna, Pa., has been appointed supervisor of air brakes, with headquarters at Hornell, N. Y.

A. Hambleton, general foreman of the Chicago, Rock Island & Pacific shops at Shawnee, Okla., has been appointed master mechanic at Eldorado, Ark., succeeding W. M. Wilson.

Humphries W. Brewer, general foreman of the Buffalo, Rochester & Pittsburgh, at Du Bois, Pa., has been appointed superintendent of shops, succeeding E. W. Williams.

G. L. Lambeth, superintendent of motive power and car equipment of the Mobile & Ohio, announces that his headquarters have been changed from Mobile, Ala., to St. Louis, Mo.

George F. Hess, superintendent of machinery of the Kansas City Southern, has been appointed superintendent of motive power of the Wabash, with headquarters at St. Louis, Mo.

E. A. Barnwell, locomotive foreman at Calgary, Alberta, Canada, Canadian National railways, has been transferred to a similar position at Kamloops, B. C., succeeding W. Jackson, transferred.

E. W. Wood, division general car foreman, Canada Southern division of the Michigan Central, at St. Thomas, Ont., has been appointed master car builder, with headquarters at Detroit, Mich.

George W. Rankin, assistant master mechanic of the Louisville terminal of the Louisville & Nashville, has been appointed assistant master mechanic at the South Louisville shops of the same road.

L. K. Sillcox, master car builder of the Chicago, Milwaukee & St. Paul at Milwaukee, Wis., has been appointed assistant general superintendent of motive power, with headquarters at Chicago, Ill.

George Dunglinson, Jr., assistant to the general manager of the Norfolk & Western, with headquarters at Bluefield, W. Va., has had his title changed to manager of the fuel department, with the same headquarters.

C. B. Young, manager of the Test Section of the United States Railroad Administration, has been reappointed mechanical engineer on the Chicago, Burlington & Quincy, with headquarters at Chicago, Ill.

James Davis has been appointed road foreman of engines of the Southern Pacific, with headquarters at Sparks, Nev., and C. L. Walker has been appointed motor car repairer at the Los Angeles, Cal., general shops.

C. F. Needham, mechanical and electrical engineer on the Grand Trunk railway of Canada, has been appointed assistant to the general superintendent of motive power and car department, with headquarters at Montreal, Que.

T. S. Lowe, assistant master mechanic, Sagueney division, Eastern lines, Canadian National railways, Quebec, Que., has been appointed assistant master mechanic, Montreal division, Eastern lines, with office at Montreal, succeeding J. M. Kerr, transferred.

E. Bowie, general foreman, McAdam Junction, N. B., Canadian National railways, has been appointed master mechanic of the Brownsville division, New Brunswick district, with office at Brownsville Junction, Me., succeeding W. Wright, transferred.

R. B. Bannerman has been appointed storekeeper on the Chicago division of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Fond du Lae, Wis., and J. B. Noyes has been appointed storekeeper on the Soo division, with headquarters at Minneapolis, Minn.

G. G. Yeamans, general purchasing agent of the New York, New Haven & Hartford, has been appointed special assistant to the president in charge of all matters relating to materials and supplies; and N. M. Rice has been appointed general purchasing agent, with headquarters at New Haven, Conn., succeeding Mr. Yeamans.

Harry U. Morton has been appointed president and treasurer of the Dunbar Manufacturing Company, Chicago, succeeding Thomas Dunbar, resigned. Mr. Morton was for several years vice-president and secretary of the Acme Supply Company, Chicago, the name of this company being changed in 1917 to the Dunbar Manufacturing Company.

B. W. Semmerich, formerly manager of the equipment section, railway department, of the Westinghouse Electric & manufacturing Company, has been placed in charge of the safety car division of the St. Louis office of the company. Mr. Semmerich has been for many years prominently identified with the development of the electric railway industry.

Edwin M. Herr, President of the Westinghouse Electric & Manufacturing Company has been honored by the Emperor of Japan by the decoration of the Third Order of the Rising Sun; and Loyal A. Osborne, senior vice-president of the company has received the Fourth Order of the Rising Sun. Both of these accomplished Westinghouse officials have done excellent work in the introduction of electric appliances in the Orient.

Harry L. Gettys has been appointed master mechanic of the Virginian, with headquarters at Roanoke, Va. Mr. Gettys entered railroad service in 1892, and after serving an apprenticeship as a machinist on the Norfolk Western, joined the United States Navy during the Spanish-American war and remained in the Navy department until 1905, when he returned to railroad service, obtaining rapid promotion in the locomotive department of the Norfolk Western. In 1913 he was appointed chief inspector of locomotive construction.

H. R. Safford, president of the American Railway Engineering Association, and Executive Assistant to President Hale Holden, of the Burlington, has had the honorary degree of Doctor of Engineering conferred on him by the Faculty of Purdue University at the commencement exercises on June 9. Mr. Safford is a graduate of the University in civil engineering, and first as chief engineer of Maintenance of Way for the Illinois Central, and latterly as chief engineer of the Grand Trunk, Mr. Safford has become one of the leading railway engineers of the country. He also did excellent service during the war both in the United States and Canada in mobilizing industrial and railway resources. This is the fourth time that the degree has been granted by the Purdue University: first, to Elwood Mead, a noted sanitary engineer; to Angus Sinclair, editor-in-chief RAILWAY AND LOCOMOTIVE ENGINEERING and author of railroad textbooks, and to Dean C. L. Cory of the University of California. It is regarded as the highest honor in the gift of the University.

L. Finegan has accepted the position of general manager of the American Flexible Bolt Company with offices at Pittsburgh and Zelienople, Pa. Mr. Finegan was born in California. He started his business life as a machinist apprentice in Butte, Montana. At the completion of his apprenticeship he entered the employ of the New York Central Railroad at Buffalo and later the General Electric Company and the American Locomotive Company at Schenectady. Leaving the American Locomotive Company he went with the Delaware & Hudson Railroad as general foreman. In 1904 he became general foreman of the West Springfield shops of the Boston & Albany Railroad. In 1911 he entered the service of the Baltimore & Ohio Railroad Company as master mechanic at Glenwood, Pa., and was later appointed superintendent of shops at this point. In 1915 he was appointed superintendent of shops at Mount Claire, which position he held up to the time of his appointment to the position above mentioned. Mr. Finegan brings to his new position an unusually broad experience in the manufacture and maintenance of steam locomotives which will prove invaluable in his new position.

Don C. Wilson has been appointed assistant sales manager in charge of the railroad department of the Edison Storage Battery Company with offices at 23 West 43d Street, New York City. Mr. Wilson has been active in railroad operating and mechanical departments for many years, being formerly electrical engineer for the Union Pacific, and latterly with the Central of Georgia before entering the service of the Edison Storage Battery Company at Orange, N. J.

W. F. Howard has been appointed to the new position of shop superintendent on the Atchison, Topeka & Santa Fe, at Cleburne, Texas.

Obituary

George H. Hazelton

The death is announced on June 10, of George H. Hazelton, in his 71st year. Mr. Hazelton was for many years division superintendent of motive power of the New York Central & Hudson River, at Albany. He retired from active service last year but was called back for special duties. He had been in the employ of the company and associated roads since 1867.

John H. Pollard.

John H. Pollard, for many years master mechanic on the Illinois Central, at Centralia, Ill., and at an earlier date one of the organizers of the Dubuque & Sioux City railroad, died on June 5 at his home in Los Angeles, Cal., in the 80th year of his age. Although retired for several years he retained an active interest in railroad matters, and was widely known and much esteemed in railroad circles.

Master Blacksmiths' Association

The International Railway Master Blacksmiths' Association will hold its next annual convention in Birmingham, Ala., on August 17, 18 and 19. A. L. Woolworth, Ohio, is president. H. D. Kelley, 1427 Western Avenue, N. S. Pittsburgh, Pa., is president of the Supply Men's Organization.

Important Decision.

The suit brought by the Vapor Car Heating Company against Gold Car Heating & Lighting Company for alleged infringement of Vapor Patent No. 758,436 has been decided by the United States District Court for the Southern District of New York in favor of Gold Car Heating & Lighting Company. By reason of this decision the Gold Car Heating & Lighting Company may continue to make and sell its Vapor Valves and its Vapor System for use in heating railway cars (all pipes underneath car to be covered as heretofore), without infringing any of the patents of the Vapor Car Heating Company.

BULLETINS, CATALOGUES, Etc.

Lubrication.

The Texas Company, 17 Battery Place, New York City, in the May issue of *Lubrication*, a technical publication devoted to the selection and use of lubricants, has an exhaustive article on "Prolonging the Life of Wire Ropes," in which the development of the wire rope is interestingly sketched, and valuable instrutcions furnished as to the proper care of wire rope. It may be stated briefly that the introduction of the hemp center made properly fabricated wire ropes are available for application where only hemp or cotton ropes could be used before. The flexibility of a wire rope depends upon the number of wires of which it is formed, the size of these wires, the method of laying and the nature of the core. The greater the number of wires in a rope the greater the flexibility. Sudden jerking and snapping is more injurious to wire ropes than overloading, as the sudden strain may cause some of the wires to break. The proper precaution is efficient lubrication. When a suitable lubricant is used upon the rope the hemp core will become impregnated with it and thus serves as a reservoir from which a little lubricant is exuded from it with every movement of the rope and enables the core to protect the wires from corrosion long after the lubricant originally applied to them has been destroyed. The lubricant should be of such a kind as to remain plastic at all temperatures, in order that the rope may remain pliable. The complete details contained in the article are well worthy of perusal, and all interested may have copies of the publication on application.

Brass Making.

The Bridgeport Brass Company, Bridgeport, Conn., has issued a finely printed and profusely illustrated historical book extending to 80 pages, setting forth a brief history of the ancient art of brass making, and its early, and even recent, method of production, contrasted with that of the electric furnace process, a twentieth century achievement which has reached its culmination in the extensive works of the enterprising company. The record of the possibilities of the electric furnace form the bulk of the work, and the processes are minutely described. Of special interest is the section devoted to the Laboratory and Research department, an institution in itself, the scientific work of which makes it possible to control closely the properties of the products passing through the plant. The publication of this work is a marked deviation from the traditions of the brass industry by making an open book of the practices and processes of brass making.

Superheaters for Stationary Power Plants.

The Locomotive Superheater Company, 30 Church Street, New York, has just issued Bulletin No. T-6, describing and illustrating tests both before and after installing Elesco superheaters on the railway power plant at the shops at Conneaut, Ohio, on "The Nickel Plate" railroad. The test was conducted by the engineers of the road and the Locomotive Superheater Company. The plant consisted of three 180 horse power horizontal return tubular boilers, hand fired, the fuel being coal and sawdust. There are also 150 horse power Corliss engine—one 175 K. W. generator direct connected to a piston valve high speed engine for lights and electrical equipment, besides a 75 horse power engine for power in the woodworking shop, — air compressor, pumps and steam hammer. All of the appliances were several hundred feet from the main boiler header, and no changes were made in the pipe lines. The results of the tests showed a saving in coal consumed after installing the superheating appliances of 26.7 per cent, and a saving in water of 20 per cent, the average steam pressure being 2.5 pounds less with the superheater attachments. Copies of the Bulletin will be sent to any one on request to the company's office.

Naco News.

The June monthly issued by the National Malleable Castings Company, Cleveland, Ohio, presents a variety of good reading calculated to suit every taste. There is an excellent article on "Melting Problems," giving furnace details. The "Foreman's Meetings" is an excellent feature full of good suggestions that other manufacturing establishments would do well to imitate. The outcroppings of wit and wisdom are surprising, but when we observe that there are about a dozen editors on its 30 pages, we are reminded that in the multitude of council there is wisdom. Couplers, Journal Boxes, and National Draft Gear are so well known that they are not particularly alluded to, except on the ornamental covers that are models of artistic display.

Accident Bulletin, No. 73.

The summary of railway accidents in the United States during July, August and September, 1919, has been issued, and it is particularly gratifying to observe that the safety first movement is gathering momentum, as compared with previous years, particularly in the reduction of fatalities and injuries of trainmen. As formerly the number of accidents by trains striking or being struck by automobiles is far in excess of all other kinds of accidents, and shows the need of more drastic means of avoidance of this preventable type of grade crossing accident.

Heating System.

The Gold Car Heating & Lighting Company's modern heating system is fully described in a new forty-page catalogue supplement just issued by that company. The supplement contains complete up-to-date heating and ventilating equipment for railway cars. Their latest type Vapor Valves shown, according to this supplement, have undergone careful laboratory and severe service tests during the past winter and have proven very successful.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXIII | 114 Liberty Street, New York, August, 1920 | No. 8

The Making of Seamless Steel Tubes

Means and Methods of the Cold-Drawn Process

In spite of the popular favor with which the cold drawn seamless steel tubes are being received, particularly in high-pressure steam boiler service, it is a curious circumstance that there is a doubt in the minds of many who may be classed as users or consumers of cold drawn steel tubing that the word "cold" may be said to be cold as compared with the degree of temperature that it had attained in the furnace, or when it made its first approach to the rolls.

This is a gross error, for, while it is true that steel tubes are not manufactured with that degree of facility with which such metals as brass and copper mon with many other products, reached its culmination in the atmosphere of American enterprise and may be seen in all its interesting details in the works of National Tube Company, where the quality of the material used has largely made the results possible.

Beginning with the blooms, which are

FULL LENGTH VIEW OF COLD-DRAW BENCH IN THE MANUFACTURE OF "SHELBY" SEAMLESS STEEL TUBING

is merely relative and not exactly as compared to atmospheric temperature, a generally mistaken view being that the heated tube in its passing through the rolls gradually becomes reduced in temperature as it does in size, and finally having reached the desired proportions are drawn into tubular shape while cold, it is also true that steel tubes may be expeditiously drawn or reduced in size without being heated. It is needless to present in detail the history of the early experiments made in England in this direction. It is sufficient to state that it has, in com- of various sizes and weights, some of these being 6, 7, 8 and 10 inches square, about 11 feet long and weighing from 1,300 to 3,750 lbs., these are heated in a furnace and transferred to the rolling table of the bar mill where the bloom passes through a series of rolls which changes the square bloom into a round bar of smaller size and greater length. Some of the bars are 8 inches in diameter when finished, while others are as small as 3 inches. While still at rolling heat, the round bars are cut to different weights, according to the length and wall thickness of the finished tube, by a circular saw, and centered while still hot. The centering process consists of making

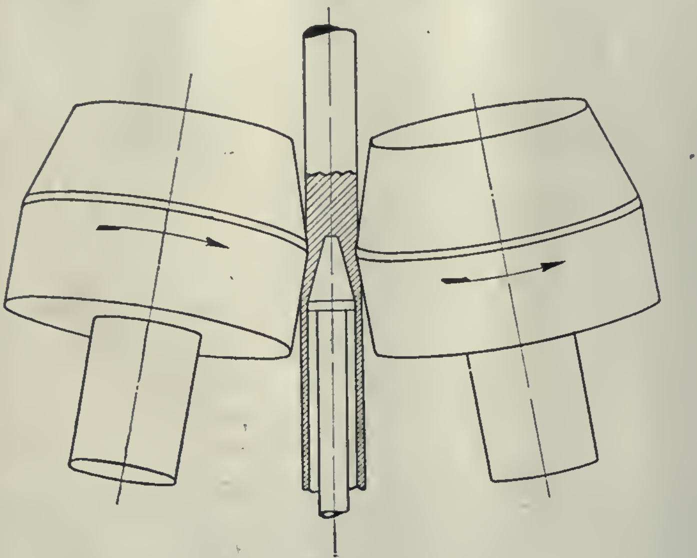


DIAGRAM OF PIERCING OPERATION

an indentation in the center of the bar by a punch, about 1 inch deep, thus producing a proper starting point, permitting the insertion of the piercing point at its most effective position for an equalized displacement of metal from the center of the billet.

The solid billet is again placed in the furnace, and, when almost white hot, is pushed into the revolving rolls of the piercing machine which force it over the piercing point of a mandrel, and so powerful are the revolving rolls of the piercing machine that the billet is transformed into a tube with apparently the same freedom as a lump of dough would be manipulated by a baker or pastry-cook, but it is without seam or weld, and all that remains to be done is to continue the process of rolling through adjustable rolls and over a mandrel held in the roll grove by a long steel bar whereby the wall thickness and diameter are reduced, and in this manner it is converted into a longer tube with walls of uniform thickness having a fairly smooth finish. While still at working temperature, the rolled tube passes on through what is known as the reeling machine. This machine consists of two heavy rolls of special design, set with axes askew, which may be adjusted to a thousandth of an inch. As the tubes are fed through these rolls, any mill-scale is removed and a smooth burnished surface is given to the tube. Trimming off the rough end, straightening, if necessary, inspection, hydrostatic testing, stenciling and placing in stock all follow in succession, and the tubes that have passed through the operations briefly referred to up to this point, are known as the "hot finished" tubes, and are distinguished from those which are intended for cold drawing to smaller sizes. When tubes are "hot finished' 'they are ready for use without further treatment in the mill, and all of the operations are performed on the tube while it is still heated, and differs from the cold drawn tubes, which are allowed to become atmospherically cold before reaching the draw benches.

Turning our attention to the cold drawn process, the tubes that are to be cold

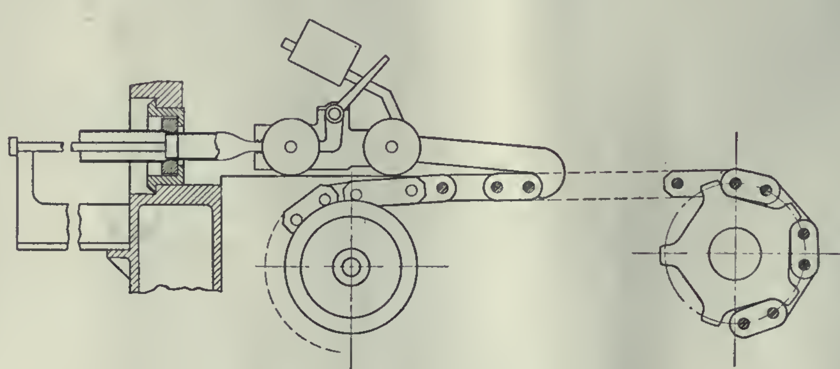


DIAGRAM OF COLD-DRAWING OPERATION

drawn are given the same piercing, rolling, reeling and sizing operations as tubes that are to be hot finished. The cold tubes are taken and heated at each end and then pointed by swaging under a power hammer. This point furnishes a "bait" which is grasped by the heavy tongs of the draw-bench in which the tube is to be drawn. It may be remarked that tubes that are to be cold drawn must be perfectly clean and free from mill scale, and to insure this they are pickled in an acid bath which is kept in constant agitation by jets of steam.

The operation of cold drawing is simple in principle, but it requires expert mechanical supervision to secure uniform, accurate results. The process is practically the same for steel tubes as it is for brass and copper tubes. The apparatus used consists of a heavily constructed steel draw bench, in the center of which is positioned the die through which the tube is to be drawn. A heavy, square-linked endless chain runs over a wheel underneath the die and travels along the top of the bench for a distance of from 40 to 50 feet to a sprocket which is geared to a suitable source of power. The chain returns underneath the draw-bench.

In the process of drawing, a tube, now perfectly cold, is partially inserted in the die with its pointed end projecting through the die. A workman slides a mandrel into the tube from the opposite end, and an operator seizes the pointed end of the tube with heavily constructed tongs which run on wheels along the bed of the draw-bench. The tongs have a strong hook that catches on the traveling chain.

By a powerful pulling force the tube is drawn or literally squeezed through the die, or between the die and the mandrel previously inserted. All tubes except those of ½-inch inside diameter and less, and those in which the wall is very heavy relatively to the diameter are drawn over mandrels. The mandrel is kept in position by a long bar, which goes inside of the tube and holds the mandrel just even with the die while the tube is being drawn. Dies are made from the very best grade of crucible steel, and are machined to the thousandth of an inch, to govern the outside diameter of the tube that is to be drawn.

The cold steel tubes, known as the "Shelby" seamless steel tubes, are drawn a number of times through dies, each of lessening diameter, to obtain the exact required dimensions, and the fact that the tubes retain all their uniform qualities through this compressing and stretching manipulation is an admirable demonstration of the general high quality of the material.

After the tube has received its final pass through the dies, which brings it down to the desired outside diameter and thickness, the swaged point is cut off and the tube passes to the annealing furnaces. The cold drawing, as may be expected, makes the tube hard and brittle, and it is therefore necessary to anneal it after each pass through the die. The process of annealing forms scale on the tube, and this must be removed by pickling after each anneal. After the last cold drawing, the tube is annealed to a suitable degree for actual boiler working and service. Any deviation from straightness is then corrected. The straightening machines are of different types. Some of them consist of horizontal and vertical rolls together, and some are nothing more than presses designed for the purpose. The tube then passes to a cutting-off machine where it is cut to specified length. When this has been accomplished, the tube is given a final inspection, tested hydrostatically, and sent to the stock rack or shipping room.

It may be added in testing the tubes a hydrostatic pressure of 1,000 pounds is applied to tubes under 5 inches in diameter, and to tubes 5 inches in diameter or over an internal hydrostatic pressure of 800 pounds per square inch is applied, provided the fibre stress corresponding to these pressures does not exceed 16,000 pounds per square inch. Indeed it would be impossible in this brief article to refer to the variety of tests and inspections that have been developed in the manufacture of tubes used for boiler purposes; the whole system, methods and practices of manufacture being made possible by the high quality which has been attained in the manufacture of the steel used, together with the mechanical ingenuity that has been exercised in the construction of the intricate and powerful machines requisite for manipulating the material towards its perfected form and finish.

ROUGH TUBE COMING THROUGH PIERCING MILL

The Metric System in Turkey.

Gen. G. Bie Ravndal, United States Consul General at Constantinople, Turkey, reports that the Turkish government has attempted to adopt the metric system of weights and measures, but, so far, the metric unit is little used. In fact, in the interim, the system is practically unknown, and it doubtful if it will be popularly accepted for many years to come, if at all. The people find the new system very much simpler from a mathematical point of view, but its units are meaningless to them until converted into the units of the old system, for the decimal system cannot be kept constantly before the mind as can the decimal system as applied to money. It is therefore infinitely more difficult to learn, and the attempt to introduce it has been productive of no little confusion.

Railroad Electrification in Italy.

In Italy a royal decree for the electrification of some 4,000 miles of state railways, and also certain private lines, has been issued. Four groups of railroads covering the whole country are included in this scheme. 300 miles of line have been already electrified in Italy.

Annual Convention of the American Railroad Association, Section III, Mechanical—(Continued)

A summarized report of the first three days' proceedings of the convention relating to locomotive matters was published in the issue for July. The following is a résumé of the reports and discussions of car matters which occupied the remaining three days:

Autogenous and Electric Welding

The report was very brief and was merely one of progress in which the committee stated that they had done considerable work on the subject assigned to them during the past year and were about to make a more thorough study as to the relative merits of autogenous, gas and electric welding of the various parts of car and locomotive equipment.

Discussion.—The discussion was opened by Professor Kinsey, a director of the American Welding Society of New York, in which he brought up the matter of the necessity for the licensing of welders. Autogenous welding has come to stay and it is being taught in the best engineering schools in the country, not with the idea of making welders, but of training men so that they will know how welding ought to be done. The matter of licensing welders is brought up from the fact that so much poor welding is being done by men who either have no conscience or no knowledge of how to make welds. The matter is under consideration by the American Society of Mechanical Engineers, but they are not advocating it at the present time. In New York City it is necessary to go to the City Hall and submit to an examination and pay a license fee of five dollars before a man is permitted to do welding within the city limits.

Objections were made to this suggestion of licensing welders on the ground that the railroad companies are not doing their work at haphazard and that they have more interest in life and safety than any other class of men, but they want to have the privilege of putting skillful men on the job without the necessity of State interference. One member objected to the section being crucified because some members of the American Society of Mechanical Engineers are representatives of insurance companies and other interested parties and cited the experience of the railroad associations in the case of the boiler code. There was a good deal said in condemnation of bad welding and the necessity for proper attention to the work was fully recognized. One of the most prolific sources of poor welds is the extended use of operators before those in charge have had time to thoroughly master the practice. Their ambition to make a showing has involved the welding of a great lot of material which was not worth welding and should have been scrapped because a weld upon poor material leaves matters worse than it was at the start. The subject of the national agreement was brought up with respect to seniority governing the selection of men for this class of work, and it was regarded as a serious matter because in certain places this seniority had authorized the placing of men not altogether qualified to do the work, simply because welding is regarded as a preferred job. And it was stated that the best way out would be to make a separate trade of it and train men especially for its duties.

Standard and Recommending Practice

Attention was drawn to some duplications and inconsistencies in the old standards of recommended practice and the guard rail and frog wheel gauge which has been eliminated, as it is a matter over which the mechanical section has no jurisdiction. The brake staff carrier iron is a duplication. It was suggested that a material should be indicated for center plates and that other matters which come under the safety application act should be eliminated. The report referred mostly to minor details and concluded with the suggestion of a monogram as a substitute for the old M. C. B. monogram.

Discussion.—The only point brought up in the discussion of any moment was that of the adoption of the monogram, and some members made a plea for the retention of the old M. C. B. as an ancient land mark that should not be removed. The monogram should be used wherever possible.

Rules of Interchange

The report of the committee contained merely the following virtual announcements:

"After March 1, 1920, no car will be accepted in interchange unless properly equipped with United States Safety Appliances, or United States Safety Appliances, Standard, *except cars moving home on car service orders for equipping with safety appliances. Cars will not be accepted from owner at any time unless equipped with United States Safety Appliances or United States Safety Appliances, Standard.*

"Cars built after November 1, 1920, will not be accepted in interchange unless equipped with 6 in. by 8 in. shank A. R. A. Standard Type 'D' Couplers."

Repair Shop Layouts

The committee presented a diagram of a layout for freight car repair shops, a tool layout for the wheel shop of the same, as well as a tool layout for a main shop, both for machine tools, wood working and blacksmith practice. The report recommended that the lorry tracks should be made to standard gauge, and where cranes are used a clearance from rails to bottom of the crane girder should be 22 ft. As far as distribution of compressed air is concerned, it is a local matter and should be treated as such. In making suggestions the committee called attention to the fact that the layout of tools and their number is more of a suggestion than as a concrete recommendation.

Discussion.—A good deal of the discussion swung about the point of whether shops should be enclosed or not, because of the suggestion of the committee that the shops be enclosed; but attention was called to the fact that the necessity for enclosing them was a matter of climate and location. In the northern parts of the country and in Canada it was recognized that it would not only be necessary to enclose the shops but also to heat them, and the suggestion was made that the heating apparatus might be reversed in the summer-time and used for cooling purposes. Some of the speakers were of the opinion that throughout the whole of the south a shed that gave shelter from snow and rain would be all that was required, but attention was called to the fact that in all parts of the south except Florida and along the Gulf coast and through Texas there were times of the year when the thermometer fell to 15 or 20 degrees above zero, and that at such times the men, who were not accustomed to such a cold climate, could not and would not perform good service, but were mostly concerned in standing around the fire and keeping warm, and it was therefore urged that the enclosed shop was therefore advisable in any part of the country.

There was a feeling, too, that the car department had not been treated with the same consideration that the locomotive department had been, and that car repairs were made under more unfavorable conditions than were those of locomotives. The matter of thoroughly equipping a good shop was urged as a paying proposition, and Mr. Giles, of the Louisville & Nashville, stated that in 1909 that road had purchased a large number of steel cars and that they had built a shop for the express purpose of repairing and maintaining, and, if necessary, building all steel equipment. The shop cost about $300,000 and is considered to have been one of the best investments upon the road.

The labor question came up in connection with the shop equipment, and it was contended that now that the cost for unskilled labor had risen to the heights that it has, the only means of bringing maintenance cost down to figures that prevailed some years ago would be to give more thought to the putting up of proper facilities for handling the work and that many things which had been done by hand labor before, and are still being done in that way, could be performed much more economically by mechanical means and that this was the way by which these costs could be cut down.

Amalgamation

The committee reported that they were in conference with a number of the minor railroad associations for the purpose of amalgamating them with Section III, Mechanical. The Master Car Painters' Association is the only one that has formally accepted the invitation. There was no discussion.

Standard Blocking for Cradles of Car Dumping Machines

The committee reported that two car dumping machines have been equipped with the recommended practice for blocking, but that the work was done after the close of navigation last fall, and there has not yet been an opportunity of examining the work of the devices since navigation opened this year. There was no discussion.

Standard Method of Packing Journal Boxes

Preparation of New Packing.—The waste must be loosened, placed in a saturating vat and kept completely submerged in car oil, at a temperature of not less than 70 degrees Fahrenheit, for a period of at least forty-eight hours to insure thorough saturation. It shall then be drained for the purpose of removing the excess oil, until the packing is in a resilient or elastic condition.

Prepared packing in storage should be turned over at least once each twenty-four hours, or the oil which has accumulated in the bottom of the container shall be drawn off and poured over the top of the prepared packing.

Preparation of Renovated Packing.—All packing, when removed from journal boxes for the purpose of periodical repacking or renovating, should be pulled into a container, avoiding contact with the ground or any other place where it may pick up dirt, and taken to the waste-reclaiming plant. This packing must not be reused until renovated.

In reclaiming packing it should be first picked over carefully and dirt, metal, etc., shaken out, the knotted strands of waste pulled apart, and then placed in hot oil in renovating tank for a short time, working it with a fork for the purpose of thoroughly washing and loosening it. It should then be rinsed in clean oil, then drained for the purpose of removing the excess oil.

Cleaning Boxes.—Before packing a journal box the oil cellar shall be thoroughly cleaned of all dirt, sand, scale and grit, and if water is present it must be removed. When new journal boxes are applied, or when reapplying journal boxes, the interior of the box, including the dust-guard well, shall be so treated, and close-fitting dust-guards and lids should be applied.

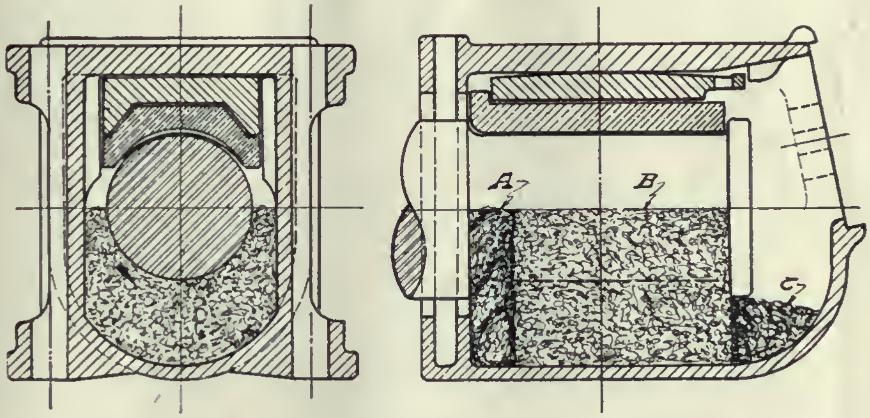
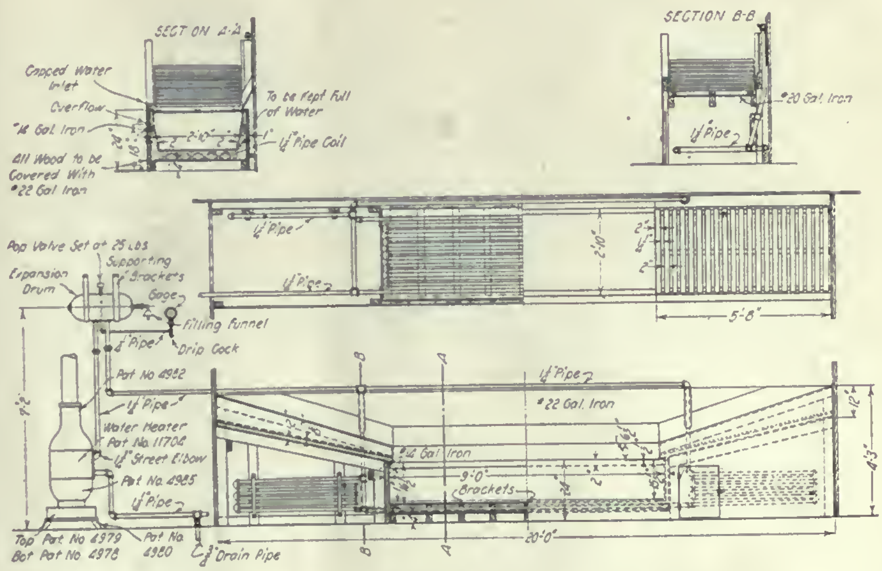


FIG. 1, METHOD OF PACKING JOURNAL BOXES

Cleaning and Applying Bearings.—Before applying journal bearings they shall be thoroughly clean, have a smooth bearing surface, free from irregularities, and shall have a proper bearing. Under no circumstances is it permissible to use sand paper, emery paper or emery cloth for the purpose of removing irregularities from the bearing surface. A half-round file or scraper should be used. Care must be taken that the wedge has a good contact on the crown of journal bearing. The surface of the journal should be smooth and thoroughly clean before bearing is applied. When applying a journal bearing a coat of lubricating oil must be applied to the bearing surface of same.



WASTE RECLAIMING PLANT; USING STOVE TO HEAT WATER

Never wipe the bearing surface of the journal bearing with waste.

Application of Packing.—(a) Inner.—In packing a journal box, twist somewhat tightly a rope of packing and place it in the extreme back part of the box, as shown at A in Fig. 1. Make sure that it is well up against the journal so as to properly lubricate the fillet on the journal and keep out the dust or other matter.

(b) Main.—Apply sufficient packing (preferably in one piece) to fill the space shown at B in Fig. 1. Take care to have this packing bear evenly along the full length of the lower half of the journal. The packing should not be too tight, but should be tight enough to overcome any tendency to settle away from the journal. The packing should extend to approximately the center line of the journal, but not above at any point, and should be pressed down evenly at the sides that no loose ends may work up under the journal bearings.

(c) Outer.—Apply a third piece of firmly twisted packing as shown at *C* in

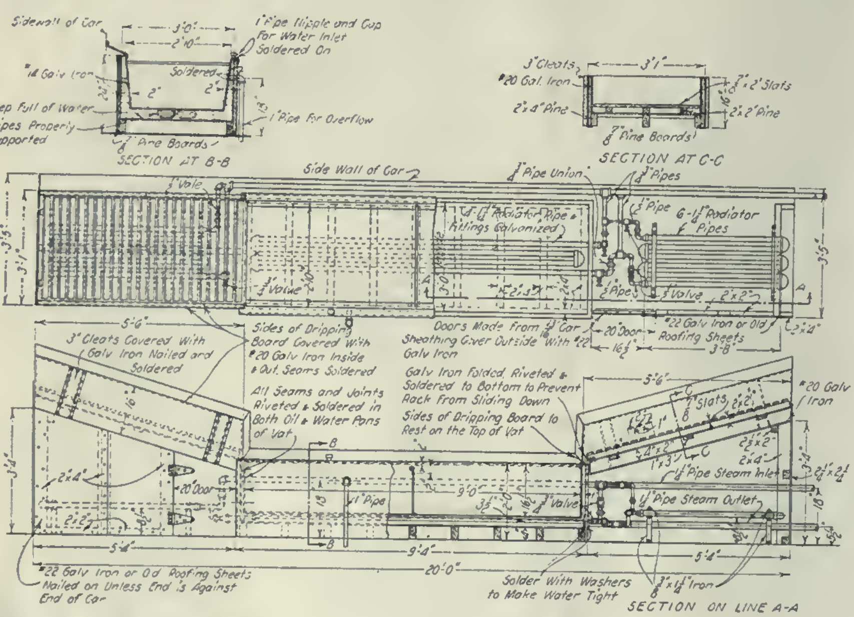
Fig. 1, and pack tightly in order to prevent displacement of the main packing. There should be no loose ends hanging out of the box as they would tend to draw out the oil.

General Remarks

In addition to the above recommended practice the committee desires to emphasize the importance of causing the observance of several other factors as follows, with the view of reducing hot boxes to the minimum:

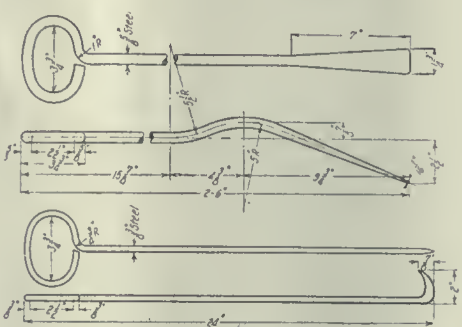
It is very essential that journals, after being turned, should be cylindrical, free from taper, tool marks, ridges, corrugations and other defects. In other words, a turned journal should reflect first-class workmanship which is only possible of attainment through the use of machine tools, in good condition, of a design suitable for the nature of the work and capable of producing it with precision. This committee feels that an attitude of indifference prevails in many quarters with respect to the necessity of providing suitable heavy-duty lathes for the machining of axles, especially the larger sizes, and, as a result, many obsolete and worn-out axle lathes are being continued in service, whereas a close examination would disclose defects in the machining of the axles that would prove such lathes incapable of meeting the requirements and warrant their retirement from service.

It is suggested that the attention of all concerned be directed to the necessity of fully protecting journals against rust and corrosion during storage and that due care should be exercised in the handling and shipment of mounted wheels to guard against the damage which journals are subjected to through coming in contact with flanges of wheels as a result of improper loading or careless handling around shop yards.



WASTE RECLAIMING PLANT; USING STEAM TO HEAT WATER

It is also highly desirable that rigid instructions be issued to effect a more careful practice in the handling of journal bearings, especially for shipment, to prevent the indiscriminate tossing of journal bearings against each other, thus nicking and needlessly damaging the smooth surface of the babbitt metal lining.


JOURNAL BOX PACKING TOOLS

The committee submitted drawings showing two representative waste-reclaiming plants and a set of journal box packing tools, which are here reproduced in the accompanying engravings.

Discussion.—The recommendation of the committee for the application of a firmly twisted piece of packing at the front end of the box which was known as the wedge was the storm center of the discussion, and the experiences were given that were diametrically opposite. It appears, for example, that the New York Central operated very successfully without the wedge, whereas on the Pennsylvania System with the No. 2 packing, it has been found necessary to continue the use of this front plug or wedge. It was claimed that the value of this part of the packing depended altogether on how it was put in. If it is put in carelessly it does no good; but, if it is put in properly, it does a great deal of good. The proper method as recommended is that it should be twisted or rolled and locked under the collar of the journal when it will stay there. It saves the waste at the center of the journal from rolling out, which it will otherwise do. It also serves the purpose of catching the dirt and anything else that works in when the oil box lids are missing. The opponents stated that the wedge would be all right if there were any means of holding it in place, but that it would be crowded up and brought to the front and that it was apt to deceive the car inspectors who would raise the journal box lid, and seeing the box well filled with waste, would let it go without giving it the attention which it really required.

The committee's recommendation for the proper preparation of the journal was strongly endorsed and it was thought that a great many difficulties arise from journals not being turned with a broad-nosed tool, causing ridges in the journal which could not be rolled out and which have a rasping effect on the journal bearing, thus destroying the lubrication, and if packing is not very carefully applied the ultimate result will be hot journals. The importance of good dust guards and tight journal box covers was strongly emphasized and then supplemented by the statement of one member that they did not as yet have any satisfactory dust guard. The Louisville and Nashville has been using the practice recommended by the committee for packing journal boxes for 15 or 16 years with great success, and yet they have been using the press for preparing packing for probably five years with equal success. Attention was called to the fact that it frequently happened that the plugs were taken out of some cars and used for packing others because the box appeared to be all full. The suggestion was made that ridges be put across the front of the box to prevent the packing working forward, and it was stated that this had been used by the late William McIntosh for a number of years.

Establishment of a Comparative Research Bureau

The committee has collected a large amount of information covering the needs and requirements of a research bureau, but asked to be permitted to continue this study before making a final report. In the report submitted the scientific rating of apparatus to be used for research work and the study of its adaptability for railroad investigations was made a special point. It was also suggested that a careful investigation should be made of foreign practice with a view to its adoption, provided sufficient merit were to be found, and suggested that accurate tests could be made by such a bureau, which would increase the operating efficiency of all railroads interested and, if this were to be done, the engineering talent of all railroads and kindred organizations would be available to aid any particular project. In this way large scale investigations would be possible, the expense of which would be prohibitive for any one road under present conditions. The work of the bureau should, of course, be of service to railroads, as a whole, through the investigations which would be instituted. There was no discussion.

Depreciation of Freight Cars

The committee recommended that the reproduction cost of cars on which depreciation is calculated be based on the per lb. basis for the various cars specified, with an additional allowance for wrought steel wheels which shall be the difference between the cost of cast iron and wrought steel wheels.

As for the rate for depreciation it was placed at 3 per cent for all steel cars, 3½ per cent for wood having continuous metal center sills with a variation of 2¾ per cent for certain types of wooden cars, 4 per cent for all other cars, including wood and tank cars.

Discussion.—The discussion consisted mostly of questions regarding the reason for certain of the recommendations which were answered by the committee.

Tank Cars

The work of the committee during the past year has been largely devoted to details of construction, and as these details have not yet been settled in a manner that is satisfactory, this report is principally one of progress. The report opens with a discussion of the safety valve problem and gives a list of 13 makes of valves that have been subjected to an extensive series of steam tests at Altoona.

The first requirement of a tank car safety valve is that it shall adequately relieve the internal pressure, and as many tanks are weakened by high fire temperature, and some have stretched and burst, no valve of a capacity less than the standard can be considered. In the designing of a valve, the greatest difficulty seems to be in securing complete tightness up to the popping pressure, and all tests show that leakage began below that pressure, and in some cases very materially below. With the old straight refinery gasolines this was not a matter of prime importance, but with the products of today, either straight or blended, derived from natural gas, the situation is very different. Some of these volatile products have a vapor tension as high as 20 lbs. at 100 degrees F., and it is important to prevent the escape of the vapor, not only from the standpoint of conservation, but because of the dangers arising from the escaping vapor. The problem has been taken up with several manufacturers of locomotive safety valves who have been encouraged to submit their own designs, the only restriction being that they should be interchangeable so far as fittings are concerned with the standard valve.

The requirements are that one valve shall be provided for a tank of a capacity of 6,500 gallons or less, and 2 valves for a tank capacity of more than 6,500 gals. A tolerance of 150 gals. has been added to the capacity of 6,500 gals. to make up for variations in construction.

A bottom outlet valve is the detail that seems to have given the most trouble because this pipe projects below the sills for the attachment of the unloading connection and is therefore very apt to be struck and broken off in case of an accident.

Designs for closing the dome are under observation, both with the screw dome cover, which is in general use, and the cover of the bolted and manhole type.

Owing to the diversity of the methods of the application of heater pipes a subcommittee has been appointed to investigate the whole subject. When the pipes are used it is the practice to make an opening in one of the heads for handling the pipes in and out. As there have been a number of failures of the plugs to hold at these points, the committee recommended that, where plugs are used in the heads of tanks of new cars or as replacements in existing cars, they shall be solid, of a good grade of cast iron and of the standard pipe thread of such a length that it shall screw at least 6 threads inside of the face of the fittings or tank.

The quality of plates for tanks is one that is giving a good deal of trouble because, during the war, it was impossible to obtain flange steel in sufficient quantities to meet the requirements, with the result that many tanks were built of tank steel, and now a number of builders have large quantities of this material on hand which is being used for new construction, and the steel people complain that the requiremenuts that a test piece shall be made for each plate rolled calls for so many tests that with the present practice they have not room to store the plates awaiting tests.

Discussion.—The report of the committee was presented by Mr. A. W. Gibbs, who emphasized the matter of the bottom discharge valve and also of the fact that some manufacturers have been very fair in ordering flange steel in advance and making cars of it, while others have loaded up with tank steel far beyond any possibility of delivery within the time specified and to extend further the time for the use of all flange steel would be to put a penalty on the people who have tried to meet the views of the committee. Other speakers supported the position of the committee on the subject of flange boiler plate.

Brake Shoe and Brake Beam Equipment

The committee opened its report by reference to the fact that the increase in the light weight of cars made it necessary that there should be a 15,000 lb. brake beam among the standards, and called attention to the fact that among the M. C. B. sheets a No. 2 standard brake beam with details was shown, which specified definitely a 1¼ in. tension member, and it appears that without further action the No. 2 brake beam capacity stands at 15,000 lbs. and the size of the tension number definitely at 1¼ ins. It was suggested that in recognition of this 15,000 capacity beam that it be known as the 2½ beam, and if this plan is accepted that the 2½ be replaced by 2 X, for the reason that this designation will serve all purposes and be susceptible of clear indication in casting. It is also suggested that on account of the comparatively few numbers 3, 4, 5 and 6 beams now in service that the 15,000 lb. beam be introduced as No. 3, and the numbers applying to the higher capacity beams be moved up to make room for this insertion. Attention is called to the desirability of revising the interchange rules in the matter of beam capacity. These have required that the No. 1 beams of 6,500 lbs. capacity must not be used on cars having a light weight in excess of 35,000 lbs. Although many cars exceeding this limit are operating with beams which would classify with No. 1 or less, it is appreciated that it is desirable that a maximum weight of cars should be determined from which the use of a 12,000 lb. beam would be barred. The committee, however, did not make any specific recommendation in regard to this matter, because the car construction committee has the same matter under advisement.

The committee called attention to the punishment which is imposed upon beams which are hung up at other than that height of hanging in which the line of the strut remains in plane parallel to the top of the rail. It appears unreasonable to expect beams to stand successfully the transverse stresses by application of loads in directions other than that of those of the strut center line or what may properly be termed the plane of the beam. In order that beams may be hung at proper heights the committee is undertaking to arrange a gauge with which these hanging heights may be determined.

The repair facilities of brakebeams are surprisingly crude. So much so that comparisons cannot be made between new beams delivered under specifications and those repaired by the railroads. The specifications require that a standard 12,000 lb. beam shall deflect .07 ins., and yet out of a test of 6 No. 2 beams taken at random only one came up to the specifications, while of the other 5 one gave the maximum deflection at 7,580 lbs. Inasmuch as repaired beams go into exactly the same service as new beams it may therefore be reasonably expected that beams once repaired become repeatedly candidates for further repair. The committee undertakes to make this question of beam maintenance, conditions, facilities and practice the subject of particular study during the coming year. The committee, after having analyzed the situation, submits as a recommended solution of the brakehead depths the adoption by letter ballot of 3 depths of heads to be known as A B and C.

The committee reported last year that consideration was being given the advisability of presenting a report on the state of the art as regards brake beams and brake shoes on account of the freedom which could be exercised now by reason of patent expirations and to the consideration of replacing the previously existing cast iron shoe design with a design covering the practically universally used steel back shoe. It is found that this is almost in universal use, and it makes recommendations for its adoption. These recommendations are to the effect that the shoe will be steel backed instead of cast iron; that the 1/8 in. recess at the back of the shoe will be eliminated; and that the overall length of the shoe be increased by 3/16 in metal at top and bottom so that its overall length is increased from 13 3/8 ins. to 13 3/4 ins., which has been the very generally adopted practice for some time; that the top and bottom guide lugs, instead of being reversed, shall be built up to the height of the adjacent top and bottom cross bearing lugs; that the key-slot be increased from 9/16 of an in. to 13/16 of an in. by removing metal from the bottom of the key opening, and finally that the inside brake shoe radius be made 17 ins. instead of 16 3/8 ins. This will insure that a new shoe bears against the wheel at its center instead of at its end, and especially when the wheel has been somewhat worn. It has also been suggested that the thickness of the shoe be increased from 1 1/2 to 1 3/4 ins., with a corresponding increase in weight from 20 to 23 lbs. This will cut down the cost per ton of shoes consumed from $90 to $83. The committee has also made some study of the reversible strut and find that it originated about 20 years ago and was afterwards abandoned because it did not prove entirely satisfactory. At the time of its introduction the stresses put upon brake rigging were very much less than they are now, and in making a strut of three pieces it would be difficult to have it rigid enough to meet modern requirements. The advantage of avoiding rights and lefts and of carrying a corresponding large quantity of repair parts was duly considered, but did not seem to outweigh the disadvantage due to the structural weakness of the reversible strut.

In previous standards the deflection load for the No. 5 beam is shown as 30,000 lbs. The commercial sizes that may be most efficiently used for the construction of beams approximating this capacity lend themselves better to a construction of a 28,000 lb. beam, on which account the committee recommends that the deflection load for the No. 5 beam be changed from 30,000 to 28,000 lbs. In order to produce a 30,000 lbs. beam commercial sizes must be resorted to which would lend themselves to the construction of a much larger capacity beam.

During the coming year the committee proposes to give attention to the development of a gauge to be used for the purpose of determining the hanging heights of existing beams; to a code of instructions for brake beam maintenance; the advisability of introducing a specification for some form of brake head strength test; the advisability of increasing initial brake shoe thickness from 1 1/2 to 1 3/4 ins., and it recommends for adoption by letter ballot of standard brake beams of 12,000 lbs. to 15,000 lbs. capacity; of the A B and C brake head depths; the brake shoe key and the brake shoe wedge; the adoption of a new section of loop hanger eye; the alteration of the deflection load of the No. 5 beam from 30,000 lbs. to 28,000 lbs. in addition to a few other minor matters.

Discussion.—The discussion was very brief and simply consisted of a recommendation that the details of a 12,000 lbs. beam be shown and a statement on the part of the committee that it hopes within a couple of years or perhaps sooner to be able to recommend that the three heads now suggested be replaced by one or two.

The chairman of the committee added that they had three or four schemes before them for the solution of the brake beam problem. One was that they eliminate from the standards entirely the 6.500 lbs. beam and give the 12,000 lb. brake beam the No. 1 designation, the 15,000 lb. beam the No. 2 designation and the remaining beams to remain unchanged. Another was to retain the 6,500 lb. beam, tion to call the additional beam 2 + is the lb. No. 3 and change the numbers of all the higher capacity beams. The proposition to call the additional beam 2+ is the preferred method, and the committee asked that it be passed on to letter ballot, and it was voted that this be done.

Couplers and Draft Gear

The committee reported that they had closely followed the manufacture of the gauge of the D coupler since it had been made the standard of the association. Some slight changes have been made in the details of manufacture and brought to the attention of the committee from time to time.

The United States Railroad Commission has conducted a very valuable series of tests on draft gears and attachments, the results of which will be given to the members as soon as the data can be worked out and tabulated.

There was no discussion.

Car Wheels

The committee recommended that there should be placed upon the recommended practice of the association a general design of 650 lb. and 750 lb. wheels to take the place of the 625 lb. and 725 lb. wheels which are now in use. It is also recommended that the present method of stenciling tape size of cast iron wheels be discontinued and a permanent record be provided. To do this five small lugs 3/8-in. in diameter by 3/8-in. high are to be cast on the inner plate near the hub. As each wheel is taped the necessary number of lugs are to be broken or cut off. Those remaining to indicate the tape size. This practice has been followed on some roads and has been working satisfactorily. In 1912 a contour of the back of the flange of steel and steel-tired wheels was changed so as to be identical with the flange contour of cast iron wheels and the width of rim was increased from 5 1/2-in. to 5 19/32-in. The process of manufacturing wrought steel wheels is such that the present contour is very difficult to produce and is not being furnished by any of the manufacturers, but instead is flanged in accordance with the design adopted in 1909. This does not, however, cause any error in check and mounting gages. The committee calls attention to a recommendation made by one of the steel wheel manufacturing companies that the specifications required wheels to be machined to exact diameter. The committee sees no justification for this added expense and did not concur in the recommendation. It was also suggested by certain of the manufacturers that the 38-in. wheel be dropped from the standards, but it was found that it is still in use in certain places where it is necessary to use wheels of that diameter to afford a proper clearance between motor housings and track, and while the use of the diameter should be discouraged it is thought best to leave it among the standards.

The following is submitted with recommendation that it be adopted in place of the present recommended practice for mounting wheels:

Recommended Practice for Mounting of Wheels

1. Standard table of mounting pressure:

Mounting Pressures in Tons.

Axle.	Wheel Seat Diameter, Inches.	Cast Iron Wheels. Minimum.	Cast Iron Wheels. Maximum.	Steel Wheels. Minimum.	Steel Wheels. Maximum.
A	5 1/8	30	45	45	60
B	5 3/4	35	50	50	70
C	6 1/2	40	60	60	80
D	7	45	65	65	85
E	7 5/8	50	70	70	95

Discussion.—Attention was called to the fact that wheels are being mounted with worn wheel gages and it has been found that gages will wear as much as ¼-in., which throws the wheels out a corresponding amount and it was suggested that it would be well to keep them checked up in order to replace them before they are excesively worn. In regard to the matter of turning steel wheels it was stated that, on the Norfolk & Western, wheels that have been turned to their second or third period of service had given less trouble in tender service on account of wearing than wheels that are rolled and it is possible that they will adopt the standard practice of using turned wheels in all tender service.

It was also suggested that inasmuch as a number of roads are using the reinforced flange and cast iron wheels, it would be well to have a standard gage for their mounting. This was objected to on the part of the committee on the basis that it would be absurd to have a standard gage for applying wheels that were not standard and this was supported by the general consensus of opinion.

There was quite a discussion on the subject of grinding cast iron wheels that had worn flat and one road stated that it had been doing this work for about 10 years and that it had been one of the best saving propositions that was ever adopted. During the period of Federal control they ground a good many wheels for other roads and so far as is known there never was any dissatisfaction with the results. In doing this great care is taken that the chill is not ground down too far or so that there is never less than ⅜ in. of chill beneath the tread. If this is done there would be no trouble about the wearing through on account of softness of the metal.

On the other hand it was stated that in an investigation of derailments due to burst cast iron wheels it was almost invariably found that this bursting of the wheel originated in fine transverse tread cracks that had been brought about by the sliding of the wheel at that particular point. And it was asked as to what the observations of others had been in this respect. To this a reply was made that most wheels burst in other directions rather than from the hub. Wheels break through the rim, but this as a rule starts in the plate and it is not thought that these breaks are due to brake burns. In fact a badly burned brake wheel is not reground. Before the war the cost of grinding was 53 cents but it has now risen so that it costs about one dollar to regrind a wheel.

Safety Appliances

The committee reported that the Interstate Commerce Commission had declined to extend the time for the application of safety appliances and in view of this action a circular was issued reading as follows:

"After March 1, 1920, no car will be accepted in interchange unless properly equipped with United States Safety Appliances or United States Safety Appliance, Standard, except cars moving home on car service orders for equipping with safety appliances. Cars will not be accepted from owner at any time unless equipped with United States Safety Appliance or United States Safety Appliance, Standard."

Loading Rules

The committee offered various recommendations in regard to loading special material again and gave special rules and diagrams for loading large flat and circular plates with the methods of securing them to the cars and closed the report with eight diagrams showing methods of blocking clearances to be allowed between the brake wheel and the loading under various conditions. This clearance was placed at 6 ins.

Discussion.—Attention was called to the fact that everyone recognized the authority of the association to formulate rules but that it depended upon the individual to see that these rules are carried out and a great deal of dissatisfaction and delay is caused at interchange points because cars are not loaded in accordance with loading rules and the interchange point is not the place for this to be taken care of. Care should be taken that cars are properly loaded because they may pass through a minor interchange point and then be held up at some large gateway, thus penalizing the intermediate road, hence it is necessary that roads exercise more supervision than they do over this matter. At the same time some of this improper loading may not be the fault of the shipper, because, as one member stated it, three-fifths of the flat cars going into a certain territory are not equipped with stake pockets. The absence of these stake pockets is the fault of the roads and not of the shippers.

Train Brake and Signal Equipment

In the 1919 report the committee recommended for recommended practice two pressure spring type retaining valves of such capacity as may be required by individual roads and left the question of standard capacity open for further consideration. As the committee is not in possession of the information that will enable it to recommend such a standard retaining valve it has appointed a subcommittee for making observations on road tests in order to determine this point. The subject of brake chain failures on tank cars received considerable attention because of the fact that many of these chains had been broken caused by their rubbing against the axle. The committee therefore published a series of diagrams showing recommended and bad practice both for the rods and the chains, which were distributed. The recommendation is that the rods be made long enough to reach preferably two inches beyond the center of the axle. The drawings of group 3 show the methods of supporting the rod so as to keep it clear of the axle. Attention was called to the location of the angle cock and some experiments were made to determine whether the reduction of the angle cock to the vertical to provide better clearance between the hose and the coupler guard arm would have an important bearing on the kinking of the hose. It was found that when cars are on a straight track and the draft gear compressed solid there is slightly less kinking of hose with a 20-degree angle than with a 30-degree, but that when the adjacent angle cocks on two cars coupled are in their extreme position on curves with draft gear under tension the 30-degree angle is the preferable one and owing to difficulties that have been experienced with leaking the change is not considered desirable.

In the matter of automatic hose connectors the magnitude of the subject is such that the committee has done little more than outline a plan to be followed in investigating the subject. Nor does the committee feel warranted in making any recommendations for the substitution of other types of packing for the leather packing of brake cylinders but does recommend that the subject be continued for further investigation.

As to the adjustment of brake power on freight equipment cars the subject was received too late for the committee to take action this year, but it will consider it during the coming year and report thereon at the next convention. Among the recommendations made by the committee for adoption by letter ballot as a standard is that of instructions for cleaning and lubricating and testing triple valves which is proposed should read as follows:

"Lubricate the seat and face of the slide-valve and slide-valve graduating valve with a high-grade, very fine, dry graphite, rubbing it on to the surface and the upper portion of the bushing where the slide-valve spring bears with a flat-pointed stick, over the end of which a piece of chamois skin has been glued, taking care to work the graphite into the pores of the metal, but leave no loose graphite on the seat. The chamois skin can be dispensed with provided the stick is made of soft wood, such as white pine, which will easily hold all the graphite that can be rubbed into the surfaces of the metal. The parts to be lubricated with graphite must be free from oil or grease."

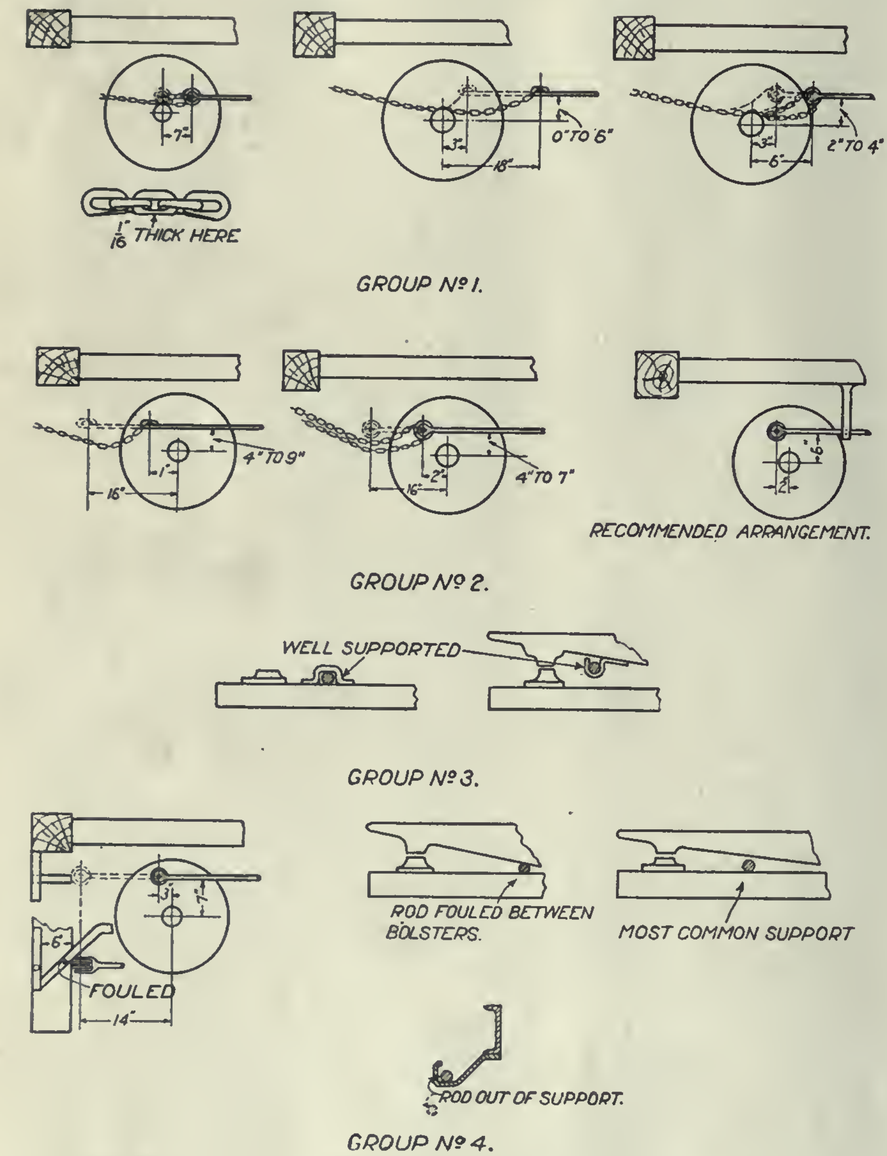
There was no discussion

Train Lighting and Equipment

The committee dealt with the various elements of a motor generator set quite elaborately and speaking of the generator frame material called attention to the fact that cast iron while costing less per pound than steel has a lower magnetic permeability and therefore requires greater weight to obtain the same electrical effect. From the service standpoint either material is satisfactory. It is suggested that generators should be overhauled periodically and by the owning road where it could best be done by dismounting and taking to the shop. That it would, also, be a matter of economy to have all generators so made that they could be put up with the same attachments. This would make it possible to substitute a repaired generator for one that would have to be taken down and do it on a minimum of time.

Attention was called to the fact that the use of ball bearings on armature shafts had practically stopped the trouble of breakage at the pulley ends and that the armature instead of being keyed directly to the axle had best be put on a quill and then the quill keyed to the shaft. The old sleeve bearings that were originally used on axle generators were a source of trouble and the instructions for fitting were very indefinite. When they were used oil was employed as a lubricant and this by traveling along the shafting to the frame became mixed with the carbon and caused a ground. With the introduction of ball bearings grease is used as a lubricant and the same trouble may be experienced in warm weather but can be prevented if grooves are machined in the bore of the end of the housings and felt washers fitting the shaft be snugly applied on the inner side of the commutator end housings and both sides of the pulley end housings.

The cutting-in speed was placed roughly at about 75 per cent of the minimum full load speed of the generator and as for the maximum speed it was a matter to be cared for both electrically and mechanically. The average diameter of car wheels generally used is 36 in. which when worn to a limit is 33 in. With a maximum train speed of 75 miles an hour the rotative speed of a 33 in. wheel is the same as that of a 36-in. wheel traveling at the rate of 81.8 miles per hour. Therefore the armature must be built to be mechanically safe when the car with the pulley ratio as intended and using a 33-in. wheel is traveling at the rate of 75 miles per hour.



RECOMMENDED AND BAD PRACTICE IN ARRANGEMENT OF BRAKE CHAINS ON TANK CARS

The minimum full load speed expressed in revolutions per minute of the armature is a factor of prime importance and until recently with axle generators used only on main line trains the full speed load was reached at approximately 35 miles per hour and gave satisfactory operation. But at the present time passenger cars equipped with electric light are operated in branch line service where the distance between stops is less than on the main line, the speed is lower and the mileage per day less. Therefore the actual time that the generator is in operation is less in branch line and local service than on main line. The report closed with specifications for axle generators.

There was no discussion.

Report of General Committee

The report of the General Committee announced that at the present time the section has a membership of 198 railroads representing 346 members in the American Railroad Association and in addition 108 railroads which are associate members of the same. These railroads have appointed 603 representatives in the mechanical section. In addition to these there are 1,235 affiliated members and 126 life members.

The following officers were elected for the ensuing two years:

Vice-Chairman:

J. Coleman, Superintendent Car Department, Grund Trunk Railway System.

Members of General Committee:

J. S. Lentz, Master Car Builder, Lehigh Valley Railroad.

H. R. Warnock, General Superintendent Motive Power, Chicago, Milwaukee & St. Paul Railroad.

C. E. Fuller, Superintendent Motive Power and Machinery, Union Pacific Railroad.

Willard Kells, General Superintendent Motive Power, Atlantic Coast Line Railroad.

John Purcell, Assistant to Vice-President, Atchison, Topeka & Santa Fe Railroad.

H. L. Ingersoll, Assistant to President, New York Central Lines.

J. J. Tatum, Superintendent Car Department, Baltimore & Ohio Railroad.

Car Construction.

The report entered into considerable detail in the discussion of a number of the parts of freight cars.

The question had been asked as to whether the application of pressed steel journal boxes in repairs constituted wrong repairs, and the committee expressed the opinion that they constituted proper repairs so long as all essential dimensions are adhered to, and further that the bottom lugs are essential parts of trucks, which depend for their integrity on the proper holding power of the bottom tie bars, but for trucks with cast steel side frames or other side frames which do not require the bottom tie bar, the lugs are not an essential part, and recommended the addition of a note to the sheet of standards to that effect.

The request that ten-foot double side doors with a movable post should be used on all box cars was opposed by the committee on the ground that the framing would be inadequate unless entirely rebuilt, and so did not recommend that all box cars should be built with wide side doors in order to facilitate the loading of automobiles.

A number of recommendations were made as to the improvement of the details of door construction.

The report also recommended that the rules which are now recommended practice should be advanced to standard.

Present axle capacities increase by steps which can be made more uniform by increasing the capacity of the axle with 5½ in. by 10 in. journals from 38,000 to 40,000 lbs., the present dimensions being such that the allowable stresses will not be exceeded.

In discussing the strength of axles, the subject matter presented should be considered as a continuation of the report of 1896.

In that report 26 per cent was added to the vertical static load to provide for the stresses set up by vertical oscillation. It was also assumed that the allowable fiber stress could be 22,000 lbs. per sq. in., hence under the static load we have

$$\text{Allowable stress} = \frac{22{,}000}{1.26} = 17{,}460 \text{ lbs.}$$

In that same report the common formula for the determination of axle diameters was used, namely

$$d = \sqrt[3]{\frac{M}{.0982f}} \text{ in which}$$

d = diameter of axle in inches,
M = moment in inch pounds.
f fiber stress of the material in lbs. per sq. in.

This formula is that of a beam fixed at one end and loaded at the other

where $M = WL$ and $ML = \frac{M}{W}$ in which

L = the length in inches
W = weight in pounds.
for a round bar the section modlus

$$Q = \frac{\pi d^3}{32} = .0982d^3$$

The common formula for the value of f in a beam fixed at one end and loaded at the other is

$$f = \frac{LW}{Q} = \frac{L \times W \times 32}{\mu d^3}$$

Transposing and substituting for L, its value $\frac{M}{W}$ we have

$$d = C\,\frac{{}^3M \times W \times 32}{W \times f \times \pi} = O\,\frac{{}^3M \times 32}{f \times \pi}$$

The report then gives a table of certain values based upon a formula for the value of M developed in the 1896 report, which is

$$M = \frac{Wb}{2} - \frac{Hh}{m}(x-b) + \frac{Hh_1x}{l} + Hh_2 + \left(\frac{w}{2} - \frac{Hh}{m}\right) h_2 \tan a \quad \text{in which}$$

b = distance from center of rail to point where journal is assumed to act.
z = distance between points of load application.
H = horizontal force caused by curves, switches and wind pressure.

h = height of center of gravity of car above top of rails.
m = distance between centers of rails.
x = any distance along the axle from the point at which the load acts.
h_1 = height of center of gravity of the car above the center of the axle.
h_2 = height of the center of the axle above the top of the rails.
a = angle of face of wheel tread with the horizontal.

In working out the values in these tables from the above formula, the committee assumed

$H = .4W$
$h_2 = 16\frac{1}{2}$ in.
$h = 72$ in.
$h_1 = 55\frac{1}{2}$ in.
$\tan a = .026$.
$m = 59$ in.
x = arm of the force.

The other hypotheses are given in the table for the several axles considered, and by substituting in the original formula the values given in the tables were obtained.

The coefficient of the arm X in the first table is obtained by the substitution of the above values for the coefficients of X in the original formula. Here we have

$$\frac{Hh_1x}{1} \text{ and } -\frac{Hhx}{m}$$

In the case of the (A) axle $1 = L + 1 = 76$ Then

$$\frac{Hh_1}{l} - \frac{Hh}{m} = \frac{6000 \times 55.5}{76} - \frac{6000 \times 72}{59}$$

$$= 4382 - 7322 = -2940$$

$$\text{and} \quad -\frac{2940}{15000} = -.196$$

In like manner the other co-efficients of X can be found.

Values for standard axles, based on distance between load applications of "L" (distance between centers of journals) plus 1 in.

Axle.	Capacity lb.	L + 1 in.	$\frac{M}{W}$	$\frac{W}{S} \times \frac{32}{\pi}$
A	15 000	76 in.	15.00414—.196X	8.751
B	22 000	76 in.	15.00414—.196X	12,835
C	31 000	77 in.	15.49821—.200X	18.085
D	40 000	78 in.	15.99228—.2035X	23.335
E	50 000	79 in.	16.48635—.2071X	29.170
F	60 000	80 in.	16.98042—.2106X	35.003

Values for ratio (R) of $\frac{M}{W}$ at edge of cylindrical center portion, at inside of collar and at wheel fit 24 in. from center and arm of force (H) on which these values are based.

That is by substituting the assumed value of X of the table below in the column $\frac{M}{W}$ of the table above we get the values in column R.

Axle.	Near Center. X	Near Center. R	Inside of Collar X	Inside of Collar R	At Wheel Fit. X	At Wheel Fit. R
A	36½ in.	7.85014	15¾ in.	11.91714	14 in.	12.23214
B	36½ in.	7.85014	15¾ in.	11.91714	14 in.	12.23214
C	37 in.	8.09821	16¼ in.	12.24821	14½ in.	12.59821
D	36 in.	8.66628	16¾ in.	12,58365	15 in.	12.93978
E	36½ in.	8.92720	19 in.	12.55145	15½ in.	13.27630
F	37 in.	9.02622	19½ in.	12.77112	16 in.	13.55682

Resultant theoretical diameters based on above tables, and standard method of calculation.

(Y = distance from center of axle.)

Axle.	Near Center. Y, in.	Near Center. Diameter, in.	Inside of Collar. Y, in.	Inside of Collar. Diameter, in.	At Wheel Fit. Y, in.	At Wheel Fit. Diameter, in.
A	1½	4.096	22¼	4.707	24	4.748
B	1½	4.650	22¼	5.348	24	5.395
C	1½	5.271	22¼	6.050	24	6.108
D	3	5.870	22¼	6.647	24	6.709
E	3	6.386	20½	7.154	24	7.289
F	3	6.811	20½	7.646	24	7.800

Brake Power and Brake Beams.—An important question in connection with car design is necessary brake power. The present standard is that the brake power shall be 60 per cent of the light weight of the car based on 50 lb. unit cylinder pressure. Cars in which the ratio of light weight to loaded weight is very low will then have a very low brake power, when cars are fully loaded. Cars in which this ratio is high have a relatively high brake power when cars are fully loaded. It is, therefore, deemed advisable to make a change, and to base the total brake power of the car on 40 per cent of the sum of the light weight plus ¼ of the maximum allowable load, and to base this on 50 lb. unit cylinder pressure. This will serve to more nearly equalize the brake power on freight cars with average loads. The possible maximum per cent of brake power for the lightest cars would be 75 per cent of the light weight of car, based on 50 lb. unit cylinder pressure. The formulæ for brake power will then be, as follows:

$$0.40\left\{\frac{W-w}{4}+w\right\}=0.1W+0.3w$$

but not more than 0.75w.

in which W = Loaded weight of car, maximum,

w = Empty weight of car,

W-w = Maximum allowable load.

As this is based on 50 lb. air pressure per sq. in. in the cylinder, and the maximum unit pressure may be from 85 to 88 lb., the maximum brake pressure will be 1.75 (0.1W + 0.3w), which, divided by the number of brake beams, will be the required deflection load per beam.

The brake beam set load, which should be somewhat within the elastic limit of the beam, should be approximately 1¾ of this amount.

Recommendations:

1. That the brake power on cars be, as follows:

W = Loaded car weight, maximum,

w = Empty car weight,

N = Number of brake beams on the car.

Required brake power = 0.1W + 0.3w, which for cars having four and six-wheeled trucks will be:

Axle.	Brake Power. Four-wheel Trucks.	Brake Power. Six-wheel Trucks.
C	13,200 + .3w	19,800 + .3w
D	16,900 + .3w	25,350 + .3w
E	21,000 + .3w	31,500 + .3w
F	25,000 + .3w	37,500 + .3w

2. That the brakebeam deflection load be $\frac{1.75}{N}$ (0.1W + 0.3w).

3. That the brakebeam set load be $\frac{3}{N}$ (0.1W + 0.3w).

4. That the 6,500 lb. capacity beam be dropped from the standards.

The report then gives a number of tables of dimensions of axles, journal bearings, wedges and boxes, with the details of the specific recommendations made in regard to each.

Then taking up the quality of steel used in car construction, the report calls attention to the fact that specifications used in car construction are varied from time to time and that it has been found that the tendency to lower the requirements for elastic limit and elongation for steel have endangered details which have been based on certain stresses, also the close adherence to requirements for ultimate strength and chemistry has caused rejection of material which was superior to material acceptable under the specifications. It is suggested that the basic requirements which will insure meeting unit stresses allowed in the past be fixed by this committee, that unnecessary restrictions be eliminated, and that the Committee on Specifications and Tests embody these basic requirements in a specification.

Unit stresses commonly allowed for detail parts of cars made of steel, and which are subject to variable loads and occasional light shock, are 12,500 and 16,000 lb. per sq. in. The minimum elastic limit should be double this amount, and the product of elastic limit and elongation should not be less than fifty times the allowable stress. As the test piece usually shows better physical properties than the casting or forging, the requirement for product of elastic limit and elongation should be increased by 50,000, making it fifty times the allowable stress plus 50,000. The reduction of area is considered secondary in importance. It should be seventy-five times the allowable stress. An addition of 50,000 for variation between test piece and the casting or forging may be made, but is considered unnecessary. The ultimate strength, content of carbon, manganese and silicon should be left optional, as the other requirements control these sufficiently and the restrictions used in specifications heretofore have caused rejection of good serviceable material.

The specifications should clearly circumscribe annealing and methods of making tests, the latter to insure uniformly comparative results from different laboratories.

The resulting specifications should be made optional for at least one year, to permit manufacturers to adjust themselves thereto.

Recommendation:

Provide specifications for all forged and cast steel used in car construction of two grades, based on fundamental requirements given below:

Grade of Steel.	A	B
Minimum Elastic Limit (lbs.)	26,000	32,000
Product of Elastic Limit and Elongation	700,000	850,000
Product of Elastic Limit and Reduction of Area	975,000	1,200,000

The ultimate strength, carbon, manganese and silicon shall be optional.

Sulphur shall not exceed .05 per cent.

Phosphorus shall not exceed .05 per cent.

The elastic limit shall be determined by extensometer.

The elongation shall be measured in a length of 2 in.

Grade "A" steel shall be annealed if the carbon content exceeds .30 per cent, or if the manganese content exceeds .75 per cent.

Grade "B" steel shall be annealed if the carbon content exceeds .22 per cent, or if the manganese exceeds .65 per cent.

Pieces of irregular section and of less carbon or manganese content, where shrinkage or other internal strains may be suspected, should also be annealed.

Unimportant details may be accepted on surface inspection only.

Fundamentals of Design.—In order to prepare the way for the design and adoption of additional standards, it is advisable to confirm or change existing fundamentals and add thereto.

Height from Rail to Center Plate Bearing Surface.—This subject was discussed at length in a number of meetings. Consideration was given to the standard height of 27¾ in. and to the U. S. R. A. height of 25¾ in. The former height would result in a distance from bottom of sills to center line of draft gear of about 4 in., an ideal condition for sills 10 in. deep, and generally satisfactory for sills 12 in. deep. The latter height is ideal for sills 14 in. or 15 in. deep, and moderately satisfactory for sills 12 in. deep. The reason for its use was apparently to eliminate bottom angles in the center sill construction and to somewhat speed up production. However, the elimination of the bottom angles, in connection with the 12-in. channel sills, results in an unbalanced section. A balanced section of the same area will have about 20 per cent greater resisting moment.

With the height of 26¾ in. from the rail to center plate bearing face, 12-in. center sills can be arranged as a balanced section and the preferable relation of center line of draft to neutral axis of center sill construction can be maintained, making this the ideal arrangement. A center sill construction with 10-in. channels can also be made generally satisfactory. Little difficulty will be experienced to adjust existing equipment of either 27¾ in. or 25¾ in. height to center plate bearing surface to the proposed height of 26¾ in. The height from rail to top of truck side bearing will necessarily have to be adjusted to suit, to maintain the relative distance of ⅞ in. from center plate bearing face to top of side bearing.

Distance Between Centers of Side Bearings.—The present rules allow various distances, and it is desirable to concentrate on one distance. The committee has selected a distance of 50 in. between centers of side bearings.

Strength Requirements for Sills and Draft Attachments.—In 1913 this committee adopted a basic figure for strength of draft attachments of 10 sq. in. of steel equivalent to grade "A" material for tension. This strength requirement was somewhat in excess of the strength of the coupler used at that time. A stronger coupler, type "D," has now been adopted, the strength value of which is equivalent to at least 12 sq. in. of steel of the same material.

In order to meet the increased requirements, and compare closely with the increased strength of the coupler, it is desirable to increase the strength requirements for draft gear attachments and center sills by about 20 per cent.

The formulæ on which the former requirements were based are as follows:

$$R = \text{Ratio} \frac{\text{Unit Stress}}{\text{End Load}} = \frac{1}{A} + \frac{X}{SM}$$

A = Area of section in square inches.
X = Eccentricity of load in inches.
SM = Section modulus.

For Draft Gear and Draft Attachments:

a. The minimum tension area=T.
b. The minimum shear area=1.25 T.
c. The minimum bearing area=0.625 T.
d. The maximum ratio $R = \frac{3}{2T}$.

For Center Sills Between Rear Followers:

e. The minimum tension area=2.5 T.
f. The minimum shear area=3.125 T.
g. The minimum bearing area=1.563 T.
h. The maximum ratio $R = \frac{3}{5T}$.

Our recommendation is to increase the area "T" from 10 to 12 sq. in. of grade "A" steel, or an equivalent area of other grades of steel, and change the other values approximately in accord therewith, which will be given in the recommendations.

Distance from Center of Bolster to Face of End Sill Casting.—In order to have uniform construction for draft and draft attachments, it is important that this dimension should be definitely fixed. The committee has selected this distance as 5 ft., which seems to meet all necessary requirements for cars with four-wheel trucks.

Draft Gear Travel, Coupler Horn Clearance, and Coupler Side Clearance.—Many cars of a length of 40 ft. and more are deficient in side clearance for couplers, and we believe it imperative that the side clearance be increased. Experience with cars with the draft gear located between center sills indicates that it is undesirable to permit the horn of the coupler to strike the end sill, and that all of the strain should be carried through the rear follower into the center sills at a distance of about 1 in. below the neutral axis of the center sill construction. Until the Committee on Couplers and Draft Gear has had an opportunity to demonstrate by test that some other travel is preferable, we recommend adopting a draft gear travel with draft gear in place on the car of 2¾ in. The coupler horn clearance should be ¼ in. more, or 3 in. The total coupler side clearance should be increased from 2½ in. to 3 in.

In this connection the minimum draft gear capacity of 150,000 lb. is recommended.

Recommendations:

The values given in the tabulation below should be approved as standard fundamentals for future design:

1. Height from rail to center of brake shoe face ....13 in.
2. Height from rail to brake beam hanger fulcrum ....24⅞ in.
3. Height from rail to bottom of truck springs ....10⅜ in.
4. Height from rail to top of springs (empty car) ....18¾ in.
5. Height from rail to center plate wearing surface ....26¾ in.
6. Height from rail to top of truck side bearing ....27⅝ in.
7. Distance from center to center of side bearing ....50 in.
8. Average clearance per side bearing per truck:
   Minimum .... ⅛ in.
   Maximum .... $\frac{5}{16}$ in.
9. Height from rail to floor of box car (minimum) ....42 in.
10. Height from rail to floor of refrigerator car (minimum)............48 in.
11. Distance between center sills.......12⅞ in.
12. Area of center sill construction between rear followers (minimum).30 sq. in.
13. Distance from center of truck to end sill face for cars with 4-wheel trucks ....5 ft. 0 in.
14. Draft gear travel (on car)..........2¾ in.
15. Coupler horn clearance...............3 in.
16. Minimum draft gear capacity....150,000 lb.
17. Coupler shank side clearance, total....3 in.
18. Draft gear follower thickness.......2¼ in.
19. Ratio of unit stress to end load (maximum) for center sills........ .05
20. Ratio of unit stress to end load (maximum) for draft attachments....... .125
21. For draft attachments the area of steel in square inches equivalent to the minimum required strength values is:
21. Tension or compression (square inches, Grade "A" steel).......... 12
22. For shear (sq. in.)................ 15
23. For bearing (sq. in.)............... 7½

Inside Dimensions of Box Cars:

24. Length ....40 ft. 6 in.
25. Width .... 8 ft. 6 in.
26. Height .... 8 ft. 6 in.
27. Hardwood, when used, must have strength values four times those given for steel.

Finally, among the minor details of construction the committee recommends the use of the corrugated steel end ¼ in. thick for all new cars and for repairs of cars whose ends are broken. It proposes to do away with the permission to use hardwood or yellow pine braces and posts, thereby making the use of steel posts obligatory, and it proposes a definite requirement as to strength of corner posts and braces.

There was no discussion.

Specifications and Tests for Materials.

The report consisted of a series of exhibits of the subjects reviewed by the committee during the past year. These exhibits consisted of the present form of the specifications and the form proposed for adoption by the committee. The specifications in the present form being those of the Master Mechanics' and Master Car Builders' Associations as they appear in their respective proceedings for 1917-18.

The first exhibit (A) was that of steel tires for locomotives and cars. Here we find a change in the required chemical analysis of the manganese content only. The present specification calls for a manganese content lying between .50 and .80 per cent. The proposed specification lowers this so that it will lie between .50 and .75 per cent. Ladle and check analyses are also added to the specifications as follows:

Ladle Analyses.—An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, sulphur and silicon. This analysis shall be made on drillings taken at least ¼ in. beneath the surface of the test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements specified in Section 3.

Check Analyses.—Analyses to represent each melt may be made by the purchaser from turnings taken from a tire or from a tension test specimen, if the tension test is specified. The chemical composition thus determined shall conform to the requirements specified in Section 3.

The physical properties of the metal is kept the same as in the old specifications, but there is added the requirements for tension test specimens, including a drawing of the standard test piece as shown in the illustrations. These requirements are that:

(a) The tension-test specimen representing each melt shall be taken from a test ingot taken during the pouring of the melt, and shall have received approximately the same amount of work as the tires which it represents.

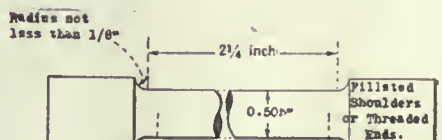


FIG. 1

(b) The specimens shall conform to the dimensions shown in Fig. 1. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial.

Number of Tests.—(a) If specified by the purchaser, one tension test shall be made from each melt.

(b) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(c) If the percentage of elongation of any test specimen is less than that specified in Section 6 and any part of the fracture is more than ¾ in. from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

Retests.—If the results of the tension test for any melt do not conform to the requirements of Section 6, a retest may be made on a specimen cut from a tire of the same melt furnished at the expense of the manufacturer. This retest shall give results conforming to the requirements of Section 6.

It is to be required that tires shall be grouped as to outside diameters and shipped in sets. But there are to be certain permissible variations from an exact agreement, as follows:

The height of the flange may not be less but may be 1/16 in. more than that specified; its thickness shall not vary more than 1/16 in. from that specified; the radius of the throat shall not vary more than ⅛ in. over or more than 1/16 in. under that specified, and the same limitations are put upon the width of the tire; the rough inside diameter shall not be more but may be ¼ in. less than that specified, but when the finished inside diameter only is specified, the rough diameter shall be from 3/16 in. to 7/16 in. less than this diameter; that unless otherwise specified, the outside diameter when 54 in. or under shall not be less, but may be ½ in. more than that specified; and, when over 54 in. shall not vary more than ⅛ in. under and not more than ⅜ in. over that specified; that the tires shall be furnished in sets and the variation in outside diameters in each set shall not exceed 1/16 in. for tires 33 in. or under in outside diameter, nor 3/32 in. for tires over 33 in. in outside diameter; and, finally, that tires shall not be out of round more than the figures given for the variation of set diameters.

The name, brand, serial number of the manufacturer, as well as the set number, are to be legibly stamped on each tire.

Tires showing injurious defects will be rejected and the samples of the same are to be retained for two weeks.

Exhibit B related to boiler and firebox steel for locomotive equipment.

In this comparatively few changes are proposed for the specifications. In the chemical analysis, the permissible range of manganese content in firebox steel is increased from a range from 0.30 to 0.50 per cent to one running from 0.30 to 0.60 per cent. A requirement for a ladle analysis is added as follows:

An analysis of each melt of steel shall be made by the manufacturer to determine the percentage of the elements specified in Section 3. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3.

In the proposed modification of the elongation requirements, the present minimum of 20 per cent is abolished and a paragraph is added that for material ¼ in. or under in thickness, the elongation shall be measured on a gauge length of 24 times the thickness of the specimen.

The only other change is the addition of the requirements that:

(a) Tension test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal test specimen shall be taken in the direction of the longitudinal axis of the ingot, and the transverse specimens at right angles to that axis.

(b) Tension and bend test specimens shall be of the full thickness of material as rolled, and shall be machined to the form and dimensions shown in Fig. 1, except that bend test specimens may be machined with both edges parallel.

Exhibit C referred to lined journal bearings and, here, the chemical analysis was completely revised and made to specify as follows:

1. *Scope.*—These specifications cover journal bearings for use on locomotive tenders, passenger train cars and freight train cars.

2. *Manufacture.*—Before lining, the brass backs shall be bored and thoroughly tinned in accordance with the best standard practice. The thickness of linings which is desired shall be specified in the order. If it is not specified, linings one-quarter inch thick shall be furnished. After lining, the ends of the bearings shall be made smooth by scraping, filing or machining. They must not be ground or rubbed with abrasive materials.

3. *Composition of Back.*—

	Per Cent. A	B
Lead	16 to 24	24 to 30
Tin	5 to 7	4 (Min.)
Total of other impurities, maximum	4	3
Copper	67 to 77	63 to 72

Within the ranges permitted, the tin and lead should vary, if at all, in opposite directions, the tin being increased for lower percentages of lead.

The owner of the equipment on which the bearings are to be used shall specify which class of metal is desired. If he does not do so, metal of Class A shall be furnished.

4. *Composition of Lining.*—

	C	D
Tin	3 to 5	0.5 to 1.5
Antimony	8 to 10	....
Antimony plus tin	12 to 14	3 to 5
Arsenic, maximum...	0.2	....
Total of other impurities, maximum...	0.5	0.5
Lead	85 to 88	94 to 96

Metal of Class C is for linings of a nominal thickness over ⅛ in. Metal of Class D is for linings of ⅛ in. or less in nominal thickness. This classification is independent of the composition of the back. Either composition of the back may be used with the composition of lining metal specified for the thickness of lining which is ordered.

5. *Analysis.*—The sample for chemical analysis of the shell shall consist of a thorough mixture of equal quantities of fine drillings taken at three points on the bearing, surface metal being discarded. The sample for analysis of the lining shall be taken by scraping the lining, after removing surface metal.

In gaging it is required that all bearings shall conform to the latest standards of the Mechanical Section of the A. R. A. with respect to form and dimensions and variations therefrom.

A new drawing of the journal brass was offered, which is reproduced herewith, which gives the markings in greater detail than the one accompanying the present specification.

Exhibit D relates to annealed and unannealed axles, shafts and other forgings.

The proposed form opens with a statement of the scope of the specifications, namely:

These specifications cover two classes of forgings, distinguished, respectively, as "Medium" and "Mild." Medium forgings are intended for the important large forged parts of locomotives, such as axles, rods, rod straps, pins, guides, etc. Mild forgings are to be used only where so ordered, for parts of minor importance, and those which are to be case-hardened, etc., and adds a paragraph that unless otherwise specified, annealed material shall be furnished for medium forgings. All axles over 6 in. in diameter at center shall be annealed. Mild forgings may be furnished unannealed unless otherwise specified.

In the old chemical analysis all steel was grouped under a single heading. This analysis is now attributed to medium forgings only, with a change of the range of manganese contents of from 0.49 to 0.75 per cent to from 0.40 to 0.70 per cent. To this is added specifications for mild forgings as follows:

Carbon	0.08 to 0.18 per cent
Manganese, maximum	0.55 " "
Phosphorus, maximum	0.05 " "
Sulphur, maximum...	0.05 " "

Requirements for a ladle analysis is also provided as follows:

An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, sulphur and silicon. This analysis shall be made on drillings taken at least ¼ in. beneath the surface of a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements specified in Section 5.

There is also an added provision to take care of the physical properties of mild steel forgings, namely:

(c) Mild forgings of all sizes shall conform to the following minimum requirements as to tensile properties:

Tensile strength, pounds per square inch.....	47,000
Yield point	0.5 tensile strength
Elongation, in 2 in. per cent	30
Reduction of area, per cent	45

Exhibit E relates to solid wrought carbon steel wheels. The only essential change in these specifications is the inclusion of the electric with the open hearth process for manufacturing.

Exhibit F dealt with bronze bearings for locomotives and the only changes from the present form were in the chemical analyses. In the case of phosphor bronze the phosphorus range was put at from 0.4 to 1 per cent. instead of from 0.7 to 1. The maximum of copper in soft bronze was raised from 65 to 69 per cent. That for medium bronze was left untouched and an analysis for hard bronze was introduced as follows:

Copper not over.......	80 per cent
Tin not less..........	8 " "
Phosphorus	0 to 0.1 " "
Lead	10 " 15 " "
Other elements and impurities not over....	1 " "

Exhibit G as to axles made a change in the permissible range of manganese of from 0.40 to 0.70 per cent. instead of the 0.40 to 0.60 per cent. previously allowed. A formula for the determination of the limitations of the permanent set is introduced as follows:

The permanent set produced by the first blow shall not exceed that given by the following formulas, in which L = length of axle in inches and d = diameter of axle at center in inches.

For axles over 65 in. in length:

$$\left(\frac{L}{1.9d} - \frac{d}{2}\right) \times \tfrac{1}{2} \text{ in.} \quad \ldots\ldots\ldots (1)$$

For axles 65 in. or under in length:

$$\left(\frac{L}{1.9d} - \frac{d}{2}\right) \times 1 \text{ in.} \quad \ldots\ldots\ldots (2)$$

To the list of axles one having journals 3¾ in. in diameter and 7 in. long is added. This axle is 83¼ in. long, and should take a permanent set of 8¾ in. under 5 blows of the drop from a height of 18 ft.

Paragraph (b) of the test requirements of the old specification relating to the method of locating test specimens for chemical analysis has been eliminated, and the following paragraph relating to workmanship and finish has been added.

Freight equipment axles, unless otherwise specified, shall have the wheel seats and journals rough turned. Engine truck and passenger car axles to be rough turned all over, except collars. The rough turning to be done with a tool of such shape that the surface is free from ridges and chatter marks.

No changes were made in the specifications for solid staybolt iron for locomotives. Exhibit H.

Then followed new specifications for hollow staybolt iron for locomotives and for tender tank hose. First was Exhibit 1 for the staybolt iron as follows:

I. MANUFACTURE.

1. *Process.*—The iron shall be rolled from a bloom, slab pile, or box pile, made wholly from reworked puddle pig iron or reworked knobbled charcoal iron. The puddle mixture and the component parts of the bloom, slab pile, or box pile shall be free from any admixture of iron scrap or steel.

2. *Definition of Terms.*—(a) Bloom is a solid mass of iron that has been hammered into a convenient size for rolling.

(b) Slab Pile.—A slab pile is built up wholly of flat bars of iron of the full length of the pile.

(c) Box Pile.—A box pile is a pile the sides, top and bottom of which are formed by four flat bars and the interior of which consists of a number of small bars the full length of the pile.

(d) Iron Scrap.—This term applies only to foreign or wrought scrap and does not include local mill products free from foreign or bought scrap.

II. CHEMICAL PROPERTIES AND TESTS.

3. *Chemical Composition.*—At the option of the purchaser and when so specified, chemical analysis shall be made, and drillings taken from tension test specimens shall conform to the following requirement as to chemical composition:

Manganese, not over 0.10 per cent.

4. *Check Analyses.*—(a) An analysis may be made by the purchaser from a broken tension test specimen representing each lot as specified in Section 10 (a). The chemical composition thus determined shall conform to the requirements specified in Section 3.

(b) Drillings for chemical analysis shall be so taken as to represent the entire cross section of the specimen.

III. PHYSICAL PROPERTIES AND TESTS.

5. *Tension Tests.*—(a) The iron shall conform to the following requirements as to tensile properties:

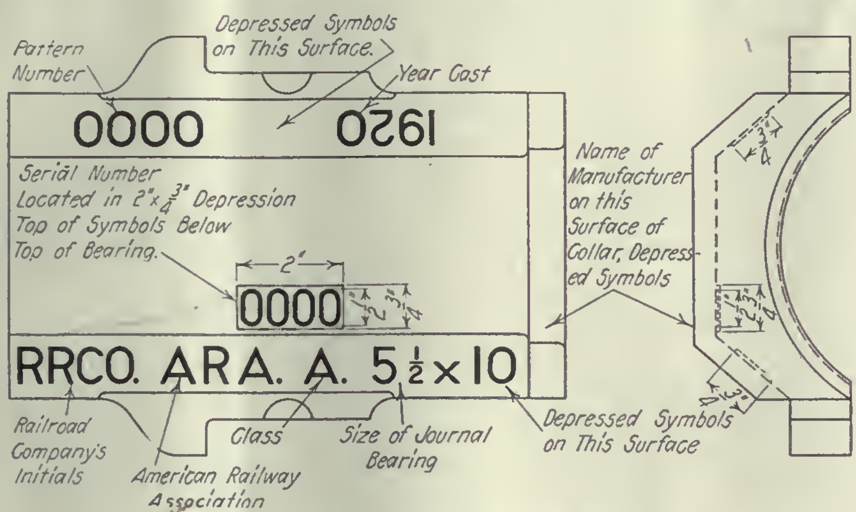
Tensile strength pounds per square inch.....	47,000-52,000
Yield point, minimum pounds per square inch	0.55 tensile strength
Elongation in 8 inches, minimum per cent..	28
Reduction of area, minimum per cent..	42

(b) The yield point shall be determined by the drop of the beam of the testing machine. The speed of the cross head of the machine shall not exceed ¾ in. per minute. For the tensile strength the speed shall not exceed 4 in. per minute.

6. *Cold-bend Tests.*—(a) The test specimen shall bend cold through 180 deg. flat on itself in both directions without fracture on the outside of the bent portion.

(b) Bend tests may be made by pressure or by blows.

FIG. 1.



DETAILS OF JOURNAL BRASS SHOWING MARKINGS

7. *Splitting Test.*—A piece not less than 3 inches long shall be split open from end to end by driving a drift through the hole. The structure thus exhibited shall be free from signs of imperfect welding and the pressure of slag or scale.

8. *Etch Tests.**—The cross section of the test specimen shall be ground or polished, and etched for a sufficient period to develop the structure. This test shall show the material to have been rolled from a bloom, slab pile, or box pile, and to be free from steel.

*A solution of two parts of water, one part of concentrated hydrochloric acid, and one part concentrated sulphuric acid is recommended for the etch test.

9. *Test Specimens.*—All test specimens shall be of the full section of material as rolled.

10. *Number of Tests.*—(a) Bars of each size shall be sorted into lots of 100 each. Two bars shall be selected at random from each lot or fraction thereof and tested as specified in Sections 5, 6 and 7, but only one of these bars shall be tested as specified in Sections 3 and 8.

(b) If any test specimen from either of the bars originally selected to represent a lot of material contains surface defects not visible before testing but visible after testing, or if a tension test specimen breaks outside the middle third of the gage length, the individual bar shall be rejected, and one retest from a different bar will be allowed.

IV. PERMISSIBLE VARIATIONS IN GAGE.

11. *Permissible Variations.*—The bars shall be truly round within 0.01 in., and shall not vary more than 0.01 in. above nor more than 0.005 in. below the specified size.

V. FINISH.

12. *Finish.*—The bars shall be smoothly rolled and free from slivers, depressions, seams, crop ends, and evidences of being burnt. The hole shall be as nearly axial and as nearly round as the best manufacturing practice permits, and shall have an area equivalent to that of a round hole 3/16 in. in diameter. The hole shall be free from slag and other obstructions.

VI. MARKING.

13. *Marking.*—The bars shall be stamped or marked with the name or brand of the manufacturer.

VII. INSPECTION AND REJECTION.

14. *Inspection.*—(a) The inspector representing the purchaser shall have free entry at all times, while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(b) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

15. *Rejection.*—(a) If either of the test bars selected to represent a lot does not conform to the requirements specified in Sections 3, 5, 6, 7 or 8, the lot will be rejected.

(b) Bars which will not take a clean, sharp thread, with dies in fair condition, or which develop defects in forging or machining, will be rejected, and the manufacturer shall be notified.

16. *Rehearing.*—Samples tested in accordance with Section 4-(a), which represent rejected material, shall be held for fourteen days from the date of test report.

Exhibit J for tender tank hose is to be:

1. *Scope.*—This specification covers non-collapsible corrugated suction hose for connections between locomotives and tender tanks.

2. *Classification.*—These specifications cover two classes of hose, known as "A" and "B." Class "A" shall meet all the requirements of the specifications. Class "B" shall meet all the requirements of the specifications, with the exception of the requirements for the digester test.

3. *Construction.*—(a) The hose shall be made up of the following parts, assembled in the order named:

Inner tube of rubber.
Two plies of frictioned cotton duck.
Helical reinforcement of wire.
Layer of rubber 0.07 in. thick.
Two plies of frictioned cotton duck.
Outer cover of rubber.

(b) The inner tube shall not be less than 0.07 in. thick, of a composition of rubber adapted to resist the action of hot water. It shall be smooth, uniform in quality and thickness and free from injurious defects.

(c) The cotton duck shall weigh not less than 18 ounces per lineal yard for material 40-in. wide. It shall be evenly woven from a high grade cotton and shall be free from mechanical defects. It shall be well frictioned with rubber on both sides, and in addition shall have a distinct layer of rubber on both sides, readily visible when the finished hose is cut open. The frictioned fabric shall be applied on the bias, with the edges lapped at least ½ in., but not sewed. The fabric shall be of such quality and so applied as to produce a hose of maximum flexibility consistent with meeting the requirements of this specification.

(d) The helical reinforcement shall be of thoroughly galvanized No. 9 B. W. G. (0.148 in.) spring steel wire. It shall be wound with not over 1-in. pitch throughout the length of the hose, up to a point distant from each end as shown on the drawings, or order, or for a distance equal to the length of the nipple used. At this point the wire shall be turned to a straight line parallel with the axis of the hose and shall extend to a point one in. from the ends of the hose.

(e) The intermediate layer of rubber shall not be less than 0.07 in. thick, and shall be carefully formed around the wire and securely frictioned to the duck.

(f) The cover shall be at least 0.07 in. thick of a composition of rubber adapted to resist the action of heat, abrasion and of the weather. It shall be smooth and uniform in quality and thickness and free from injurious defects.

(g) At each end of the hose there shall be an extra ply of duck extending three in. beyond the length of the nipple.

(h) The dimensions of the finished hose shall be as shown on the order or drawings. A tolerance of ¼ in. either way in length, and 1/32 in. either way in inside diameter will be allowed.

4. *Tests.* — (a) Bend Test. — Test samples will be bent 180 deg. until the two ends are parallel. The diameter of the inside of the bend shall be equal to three times the nominal inside diameter of the hose. The hose when bent in this position shall show no *kinking*.

(b) Digester Test.—This sample will then be cut into two pieces, one of which will be tested in its original condition, and the other will be placed in a closed digester and surrounded with dry saturated steam at 45 lbs. pressure continuously for a period of 48 hours. It will then be allowed to cool for a period of 12 to 24 hours, and will be tested as specified immediately afterwards. As a result of the heating, the hose shall not develop any blisters, or loosening of any parts.

(c) Friction Test.—A one-inch section shall be taken from any part of the hose so that one wire passes along the centre. This section shall be cut open and flattened out and the friction determined between the tube and canvas, between the two layers on each side of the wire, between any two layers of canvas and between the canvas and cover.

One end of this piece shall be held in a suitable clamp of a spring balance, or pendulum type testing machine, and the different plies stripped off and pulled back 180 deg. to their original position, at the rate of 20 in. per minute. Readings shall be made every five seconds for at least four readings for each ply and the average shall represent its friction.

For Class "A" hose the friction of any ply shall not be less than 18 lbs. before steaming and not less than 15 lbs. after steaming.

For Class "B" hose the friction of any ply shall not be less than 18 lbs.

(d) Permanent Set.—From the unsteamed tube and cover test pieces will be cut by means of a steel die, in accordance with Fig. 1, and will be stretched two in. to five in., held in this condition for one minute, released, and after resting for one minute the permanent set will be measured. This set shall not exceed 0.25 in.

(e) *Tensile Test.*—From both the unsteamed and the steamed tube and cover, tensile test pieces will be cut by means of a steel die, in accordance with Fig. 1. Marks 2 in. apart will be placed on the pieces which will then be placed in a suitable tensile testing machine, whose cross-head moves at the rate of 20 in. per minute. The tensile strength and ultimate elongation of both tube and cover shall be as follows, the area of each test piece being calculated from the dimensions after stripping from the canvas:

	Unsteamed.	Steamed.
Tensile strength, minimum lbs. per sq. in.	600	450
Ultimate elongation at rupture, minimum, 2 in. to	6	4
Ultimate elongation at rupture, maximum, 2 in. to	10	8

5. *Number of Tests.*—For each 200 pieces, or small lot of hose ordered, one extra piece will be furnished, and from each such lot one piece shall be taken at random for test to determine the disposition of the lot.

6. *Marking.*—Each piece of hose shall have vulcanized on it a label of red rubber in accordance with Fig. 2. The letters

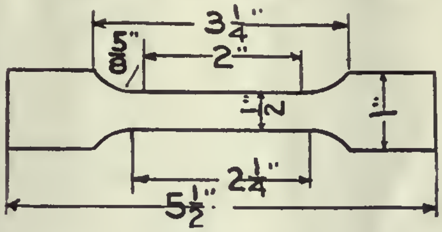


FIG. 1.

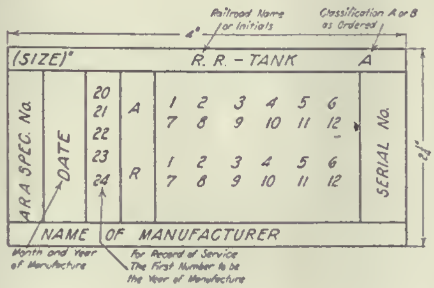


FIG. 2

and figures shall be clear and distinct and at least 1/32 in. in relief.

Each piece of each test lot of hose shall carry a serial number as a part of the label. Serial numbers shall begin with "1" on the first of each year, and for the product of each manufacturer. If a serial of hose is rejected the serial number shall not be repeated.

7. *Inspection.*—(a) The manufacturer shall afford the inspector, free of charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

(b) The purchaser may make tests and inspection to govern the acceptance or rejection of the material, at his own laboratory or elsewhere. Such tests and inspections shall be made at the expense of the purchaser.

8. *Rejection.*—Material which, subsequent to acceptance tests, shows injurious defects will be rejected. Material tested elsewhere than at the mill, failing to meet these specifications, will be rejected and shall be replaced by the manufacturer at his own expense.

9. *Rehearing.*—Samples tested in accordance with this specification, which represent rejected material, shall be preserved for fourteen days from date of test report.

Lessons About the Snow Plow

By C. RICHARDSON, Bridgeport, Conn.

W. H. Winterrowd, chief mechanical engineer of the Canadian Pacific railway, has made an important contribution to the railroad literature of our time, and while the engineering press has from time to time called attention to the improvements of the snow plow, it has been left to Mr. Winterrowd to prepare in concrete form a condensed and complete history of the development of the appliance which may be said to have reached as near perfection as can be expected. That the utility of this useful auxiliary to railroad traffic has seen its culmination on the Canadian railways is not to be wondered at. There are no such periodical accumulations of snow in any part of the world as those that occur in the Selkirk Mountains through which some of the transportation lines of Canada pass, owing to the mountainous region referred to receiving what may be called the accumulated vapor arising from the Pacific ocean being congealed when driven by the northwest winds let loose from the frozen regions of the Arctic circle across the North American continent. A snow fall of over twenty feet deep is not uncommon in the Selkirks, and by the time the fleecy shroud reaches the Atlantic seaboard the white mantle seldom reaches three feet in thickness.

Of course there is a louder wail of woe in the East because there is a denser population, and with the exception of Montreal there is little or no preparation to meet what may be expected. The officials of the municipalities are blamed for their incapacity as if they could resist the laws of nature. In New York last winter the entire population could not have cleaned the streets in a month and made no attempt at it, allowing nature to take its course while they vented their wrath in indignation meetings against the street sweepers. On the Canadian railroads they are advised when to expect the mantling visitor and the marshalled snow plows are ranked and ready, from the light sweeper to the terrible tank with armorplate revolving cutters, and traffic is hardly disturbed.

Even in the flat lands of New Jersey a few winters ago the attempt to clear away a few drifts in comparatively shallow cuttings on the railroads was a complete failure. There was no snow plow strong enough to sweep aside the impediment and broken shafts were strung along the iron highways like the remnants of a battlefield.

Now is the time to prepare for not only next winter but for the winters that are to be, and among the needed equipment we in the United States generally, and in the Eastern states particularly, might well pore over the historical essay to which I have referred, and to learn a lesson from the accomplished Canadian engineer, and when the blizzards come to remember the words of the poet Longfellow, "Beware the pine trees' withered branch, beware the awful avalanche!"

The Ideal Locomotive.

An ideal solution of locomotive difficulties would be found if it were possible always to proportion the power of the locomotive employed to the weight and speed of each train hauled. But though it is possible, to a certain extent, to allocate special engines to special duties, the necessity for limiting the hours of service of the crews, and for working the engines back to their sheds by the first available means, make this course impracticable as a general rule. The ideal being unattainable, therefore, it is found the most economical plan to legislate for extremes by designing locomotives with a reserve of tractive power more than sufficient to meet the maximum demands made upon them in ordinary service. If in the course of their duties such engines are required to work on light trains an ample fire-grate and tubes of substantial length ensure the utilization of the maximum proportion possible of the calorific value of the fuel burnt, and the total consumption is probably but little greater than that of a locomotive better proportioned in dimensions to the performance of that particular duty.

The matter is one that might well engage the further attention of locomotive construction engineers.

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Increased Rates.

A general feeling of satisfaction is expressed by the public generally and by railroad men particularly at the rate increases granted the railroads by the Interstate Commerce Commission, and which will come into operation on September 1. The increases allowed in freight rates vary from 40 per cent in the East to 25 per cent in the South and mountain Pacific region, or an average of about one third. Passenger rates will be increased one-fifth and Pullman rates one-half. The aggregate is about 90 per cent. of the claims submitted by the Railroad Executives, and although falling short of the full demand, it is not only a liberal grant in the face of a pressing necessity but may be said to be the only grant approaching to fairness ever made to the railroads by a governmental commission.

The claims of the Railroad Executives, it will be recalled, was made on a gross valuation of $20,900,000,000. The Commission reduced the estimated valuation of the roads to $18,900,000,000, and declare that the increase of rates granted will give the roads the same percentage of increase on the reduced valuation that the roads' original demands would have yielded on their own valuation. The result remains to be seen, but it may, in the light of the present liberal action, be taken for granted that any shortcoming in any particular section, or any surplus, which is not unlikely in other sections, will be rectified by the Commission which has begun its work so well.

From all points of view the prospect is full of encouragement. The shippers and the traveling public are not disposed to complain. What is needed is a speedy return to prompt transportation, and this can only be accomplished by a united effort on the part of all concerned in railroad work.

The Decision of the Railroad Labor Board.

After a delay of nearly a year the claims of the railroad employes have been met with an award of about 60 per cent of the increases asked for. The details have been published so widely in the daily press, that it is not necessary to allude to them in detail. It is particularly gratifying to observe that the awards have met with a certain measure of satisfaction, and while at the first glance it is painfully evident that there are some classes of railroad employes that have not been so liberally treated as others, in the very nature of things it was not to be expected that every one would be satisfied, but it was hoped that the distribution would be more nearly equable than it is. To those who experienced the greatest degree of disappointment there is this important consolation that the Labor Board is not a transient tribunal. The creating enactment projects itself into the unlimited future, and the same degree of patience should be cultivated that has already shown itself among the large class of underpaid employes. Popular opinion is positively on the side of those whose claims have not been met with that degree of liberal consideration that has been awarded to others. To strike would be madness. To keep the lamp of hope burning, and leave the future to those able and resolute men who have thus far have so successfully gained a good deal is the only safe course to follow. It must be admitted that the claims of the railway men have been presented with an earnestness and eloquence that would be difficult to surpass, and it may be safely assumed that the same vitalizing force will be exerted to induce the Labor Board to make amends in the near future for some of its marked shortcomings.

With the governmental guarantees to the railroads of a minimum rate of income, it need not be for a moment doubted that the money will be forthcoming. The needed increase in rates will be made as quickly as the intricate calculations can be made, and the shippers and the traveling public are already expecting the necessary increase of rates with a well calculated degree of exactness, and the effect on the prices of commodities will be so insignificant that in a few months it will scarcely be noticed. Altogether the outlook is not only full of promise, but the atmosphere of marked improvement in transportation is already an absolute assurance.

The French View of the U. S. Railroad Law.

The *Revue Generale des Chemins de Fer* recently published a very complete resumé of the recently enacted railroad law of the United States. At the conclusion of the resumé it set forth certain observations from which the law as it appears to an unprejudiced French observer can be seen. Basing his opinion on newspaper and other American comments on the law, the author concludes that the railroad officials are unanimously optimistic as to the outcome and that they feel themselves competent to show that private operation is better from every point of view than that of the government.

But an analysis of the law will show that, in many ways, their power of initiative has been considerably reduced. In short, the law introduces some innovations in the matter of tariffs and labor controversies. On the one hand, it creates the Railroad Labor Board, and, on the other, it has considerably enlarged the powers of the Interstate Commerce Commission. In fact the latter is authorized to modify rates; and to interfere if necessary in the management of affairs. Practically it can exercise, in extreme cases, the same authority in the distribution of rolling stock and traffic. The simple fact that it will determine and publish from time to time the rate which it may consider, one assuring a just return to the companies, makes it the arbiter of the destinies of the railroads of the United States.

The law also establishes the authority of a new power: the public. A large proportion of the provisions of the bill rest upon respect for "the interests of the public." The latter is admitted to the Railroad Labor Board, and its power will be such that no decision can be rendered without enlisting to it at least one of the three representatives of the public.

Hence two things stand out with prominence:

1. The powers of the Labor Board are such as to impose what practically amounts to an obligatory arbitration; *though nothing is provided for the imposition of penalties.*

2. The provisions proposed in the Esch bill for placing a representation of the organizations of employees on the board of directors has been done away with.

In short the companies come back into possession of their systems, not as stewards or even as concessionaries, but as owners. It is, therefore, a check on the policy of nationalization and the reason for this check is explained by the disastrous results of federal operation during and after the war.

Still the companies see their powers singularly limited while those of the Interstate Commerce Commission have been considerably enlarged. If we look back upon the modest start of this commission, its long struggle to obtain an increase of its functions for the control of the right even to fix just and reasonable rates and for the right to interfere in the operation and financial arrangements of the roads, we can form an idea of the long strides taken in the extension of the powers of the state. In short the commission is henceforth empowered to direct the whole policy of the railroads of the United States. If we stop to consider the importance of these functions and the role which it will be called upon to play, we may well ask whether the composition of the commission corresponds to the duties imposed upon it. It is composed solely of members nominated by the government. It contains no representatives chosen either by the companies or the employees, to justify its character as an arbiter, nor does it include among its membership any representatives chosen by the public (commerce, manufacturers or agriculture) which makes its composition all the less explicable, since it is called upon to defend the interests of the whole.

If it is admitted that the government exercises its choice not only among its own officials, but among the qualified representatives of the interests of commerce, manufacturers and agriculture, they are formed to hold their position from the government and not from the groups of which they form a part, a point which confers more or less authority and independence upon them, and this will not permit the elements which they represent to force a predetermined program upon them as would be the case were the positions elective.

If the companies see their powers curtailed, they do receive an appreciable compensation in return. While they obtain no direct financial guarantee from the state, they will henceforth enjoy an indirect guarantee, since they will be assured such just rates that they will obtain a reasonable revenue, the amount of which, subject to periodic revision, will be based on their own accounts. On the other hand, in case concessions granted to the employees, as the result of arbitration, shall make a serious modification of the conditions of operation, it follows that these concessions will, on the other hand, involve a revision of the rates. There are, then, new advantages for the companies that put their operation under the shelter of certain contingencies, which are of a nature to strengthen their credit and justify the optimism of their directors.

Furthermore it would seem as though the constitution of the Labor Board, as it is organized, will be of such a nature as to protect the companies from excessive concessions to the employees. The representation of the public on this board (although not elective in this case, and therefore apparently contrary to the principle of such a representation) requires the vote of at least one of these representatives in order to sanction a decision entirely favorable to the employees, and at the same time places a powerful brake on any tendency towards abusive concessions to the companies. The representatives of the public will not be disposed to grant excessive advantages to the employees, because they know that it is the public who will have to pay the bills. The establishment of this board seems a happy thought and it will be interesting to follow it through its practical operations.

As we have said, the new law prohibits neither a strike nor a lock-out. But we would make a serious mistake in thinking that a cessation of work on the railroads would be lawful. It must not be forgotten that the federal government is armed by general legislation with the power to break up any movement of such a nature. We must bear in mind that, not very long ago, on the occasion of the miners' strike the government took a position of firmness and strength, that might well be followed by many other governments. Seizure of the funds of the unions, imprisonment of the instigators of the movement, were threats that were made with promptness and decision, and so the strike was quickly broken. In the course of the April strike, that was directed, in part, against the new regime of the railroads, the government did not hesitate to act with very great firmness and success to end the strike.

In short, the new regime of the railroads of the United States conforms to a great extent to the concensus of public opinion, and marks a notable failure for the advocates of syndicalism. While enlarging the powers of the federal government in the sense that it co-ordinates railroad operation, turns the administration of the roads over to the companies with guarantees which they did not have before the period of government operation, under conditions which shields their credit from the contingencies to which it was previously exposed.

The United States has thus been able, before any of the other great countries where the railroad problem has come to the fore, to reconcile, under conditions that appear to be equitable, the interests of the government, the public, the railroads themselves and the employees.

Vauclain in Europe.

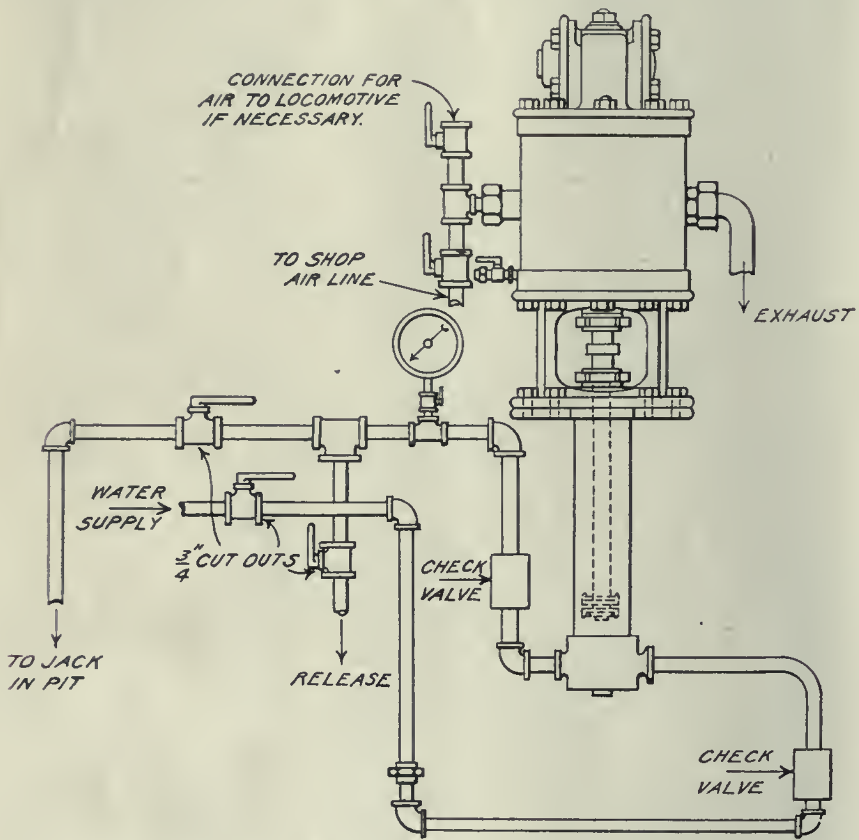
Samuel M. Vauclain, president of the Baldwin Locomotive Works, has long been recognized as a leader among constructing engineers, but the universal voice of the public and press now recognize him as a statesman of the first rank. His recent visits to Europe have opened the gateways of commerce in the darkest places in the world. The saying that all wisdom cometh from the East has had its day. The Western star has its place in the heavens, and all that is necessary is for the hopeless mariners to know where to look for it. The utter breakdown of railroad equipment, particularly in the Balkan States, left the people in a condition of hopeless misery. The old regime consisting of a governing class revelling in voluptuous luxury with the toiling millions living on the brink of muffled misery had passed into a chaotic condition of stifled stupor. Interchange of commodities had ceased. The crown jewels were in the pawnshops, it is true, but the gold and silver had disappeared. Nothing remained but the undeveloped resources of nature. Into this charnel house comes Vauclain like a ministering angel. The old question, "Can these dry bones live?" had to be answered. Vauclain answered it. He showed them where to build harbors and bridges and American enterprise would bring the locomotives and other equipment, and the oil wells and harvest fields could be made to pour out their riches, and Vauclain would find markets for them and the bewildered statesmen could send their depreciated currency paper back to the paper mills and get along without money.

This was not all: Mr. Vauclain recommended that the American soup-kitchen men and women should be sent back to America to engage in real work, instead of encouraging beggary. He claims that the people in Europe have more food than we have. All they need is the means of transportation from the rich fields to the centers of population, and it is not too much to say that from the Baltic to the Black Sea and from the German ocean to the Mediterranean the mighty impulse is already felt, and while we are not praying for miracles, a miracle is being accomplished, and it is a matter of pride and satisfaction to note that whatever may come of the League of Nations and other unrealized dreams, the real needs of the hour are beginning to be met where the atmosphere of American enterprise is being injected into the lungs of the war-worn people of Europe.

Delaware & Hudson Shop Kinks

Roundhouse Pump and Straightening Table

Among other special devices in use in the Delaware & Hudson shops at Watervliet, N. Y., is an arrangement of the pump for supplying pressure for the hydraulic jacks used in the drop pits of the roundhouse. This arrangement removes the pump from the pit, where it is more or less dangerous for the men to work, and places it at one side on the floor and converts it from a hand to an air-operated pump.



ARRANGEMENT OF PUMP FOR ROUNDHOUSE PIT HYDRAULIC JACK

The power cylinder consists of a 9½-in. Westinghouse air pump with the air cylinder removed.

There are two connections for the admission of air, so that the supply can be obtained from either a locomotive or from the regular shop air line.

The air cylinder has been replaced by an hydraulic cylinder bolted to the air pump center piece. This cylinder is formed of a length of tubing screwed into a blank head that is faced off and drilled to fit the bottom of the center piece, which provides the usual stuffing box and gland. The tubing is bored out to suit ringer leathers and is of such length as to allow a clearance of ¼ in. at each end of the stroke. The lower head, into which the piping is screwed, is formed of a brass casting made from one of the patterns in the shop.

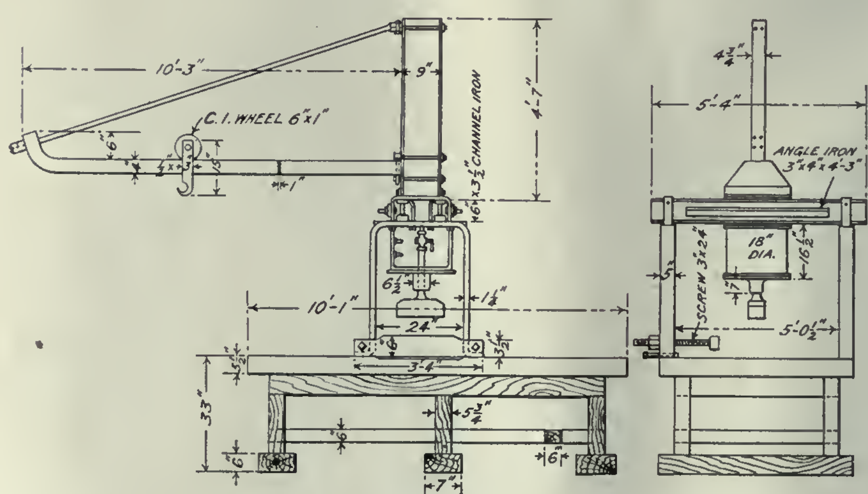
The piston rod is turned down on each end to suit the Sampson bell ringer cup leathers, two of which are used turned in opposite directions so as to pack for both the suction and delivery strokes.

The fixed piping is ¾ in. in diameter, is fitted with suction and delivery check valves. Between the delivery check and the pit jack there is a pressure gauge, and between this and the jack there is a cut-out cock, and between this cock and the gauge there is a release pipe with a cock to lead the discharged water to a proper receptacle. There is also a cut-out cock in the suction pipe between the suction check valve and the source of supply.

The connection between the piping and the pit jack is made by means of 12 ft. of steel covered duplex metallic tubing which is made for high pressure by the Pennsylvania Metallic Tubing Co., having the necessary fittings. This makes the movement of the jack about the pit easy and practicable.

In the shop there is a homemade straightening table that is very simple and handily operated. The table itself is framed of heavy timbers and has a top 33 in. above the floor. To this there are bolted two heavy yokes made of 1¼ in. by 5 in. steel. These carry two cross 6 in. by 3½ in. channels. Beneath these an 18 in. air cylinder is bolted, having a piston and rod exerting a downward thrust upon the object to be straightened. The latter can be held firmly against its blocking by a horizontal screw 3 in. in diameter and 24 in. long. The lower end of the piston rod carries the straightening head for the work.

A stick of 4¾ in. by 9 in. timber is fastened to the top of the framing, and this is protected by flat-iron nosings on each side. This serves as the port for a jib crane swinging through 180°. The arm is of 1 in. by 4 in. steel, and serves as the runway for a single-wheeled lorry with a hook on its strap on which the hoisting tackle for heavy pieces is hung.



STRAIGHTENING TABLE, DELAWARE & HUDSON CO.

Air Brake Department

Questions and Answers

Conclusion

With the present issue of Railway and Locomotive Engineering, we conclude the series of Questions and Answers in the Air Brake Department relating to "Locomotive Air Brake Inspection," "Train Handling" and "Car Brake Inspection." The series has been extended to a degree of minuteness hitherto unattempted, as far as we know, in any publication, and the marked degree of popular favor with which the work has been received among leading air brake instructors has been ample recompense for the labor of investigation and compilation. In this regard it may be stated that the series has formed a leading section of the work in many of the Air Brake instruction classes not only in America but in other countries, and the unanimity of approval of the correctness of the data has been particularly marked.

Meanwhile we have arranged with some of the leading air brake experts for the publication of articles on special subjects, and to this end we invite the cooperation of all who by training and experience may be engaged in air brake work, and whose views could not fail to be of interest to all who are similarly occupied, and on this interchange of opinion aid in the good work of a thorough knowledge of all that appertains to air brake construction and maintenance, to the end that a greater degree of reliability and economy may be established in the use of this most important accessory in the realm of transportation.

Locomotive Air Brake Inspection

(*Continued from page* 210, *July*, 1920)

1266. Q.—What would be the result of an improper connection?

A.—Likely a delay to the train and it would probably be necessary to leave the terminal operated with the pneumatic brake.

1267. Q.—What would be the probable result of crossing the lower or release magnet and emergency wires?

A.—After coupling to the train and getting the current, the brake would apply in emergency every time the brake valve handle was moved away from running position.

1268. Q.—What would be the probable result of crossing the other two wires?

A.—It would likely destroy the electric graduated release and the brakes would release during the brake test, and the electric features would probably be cut out before the train left.

1269. Q.—How are these electric wires connected between the tender and the first car?

A.—With a 7 point jumper or cable connection.

1270. Q.—And the 7 points?

A.—Make the contacts with the 7 wires mentioned.

1271. Q.—The electric current or source of electrical energy being obtained from the lighting storage battery of the first car in the train, current leaves the battery through what wire?

A.—The battery plus wire.

1272. Q.—And return through what?

A.—The battery minus wire.

1273. Q.—Current circulating through these wires what occurs when the knife switch in the cab is closed?

A.—Current flows into the emergency switch wire from the battery plus wire.

1274. Q.—Which leads to?

A.—The supply for the brake valve and throughout the train to the terminal or binding port at the emergency switch of each universal valve.

1275. Q.—As to brake operation only, what connections are made with the brake valve in running position by the contact fingers in the drum?

A.—None whatever.

1276. Q.—The release, service and emergency wires having no current, what occurs when the brake valve handle is moved to holding or lap position?

A.—The brake system being charged, or uncharged, a connection is made between the emergency switch or supply wire and the release magnet wire.

1277. Q.—And this does what?

A.—Results in a flow of current from the supply wire into the release magnet line to each universal valve and through the magnet into the battery minus wire, energizing each release magnet.

1278. Q.—And this results in?

A.—The armature of these magnets being pulled down on the core closing the magnet valve.

1279. Q.—And consequently?

A.—Closing each brake cylinder exhaust port.

1280. Q.—And if the valve handle is then moved to lap position?

A.—The electric contacts remain the same.

1281. Q.—Or to release position?

A.—The same contacts and no other.

1282. Q.—And if then moved back to running position?

A.—The contact fingers in the drum are separated and the release magnets are instantly de-energized and the magnets return to their nomal position.

1283. Q.—Assisted by?

A.—The release magnet valve springs returning the magnet valves to their original position opening the brake cylinder exhaust port.

1284. Q.—What occurs however if the brake valve handle is moved to holding, lap, and then service application position?

A.—When the valve handle reaches service position the supply wire is also connected with the service magnet wire, and current flows through the service magnets into the battery minus wire, energizing the service magnets as well as the release magnets.

1285. Q.—With what result?

A.—Pulling the armature of these magnets down on the core unseating the service magnet valves.

1286. Q.—And if the brake system is charged.

A.—The service magnet valves will admit brake pipe pressure to the brake cylinders making a brake pipe reduction at a service rate.

1287. Q.—And when the valve handle is returned to lap position?

A.—The supply wire is disconnected from the service magnet line and service magnets are instantly de-energized.

1288. Q.—With what result?

A.—They assume normal position, and the service magnet valve springs return the valves to their seats.

1289. Q.—Stopping what?

A.—The brake pipe reduction.

1290. Q.—And the release magnets?

A.—Remain energized with the brake cylinder exhaust ports closed.

1291. Q.—How is the distributing valve operated to apply the locomotive brakes, it having no electric portion?

A.—By the same brake pipe reduction that applies the universal valves.

1292. Q.—What is the difference between electric and pneumatic operation of the universal valve?

A.—Instead of brake pipe pressure being discharged from the brake valve service exhaust port, it is discharged into the brake cylinders by each universal valve in the train.

Train Handling

(*Continued from page* 211, *July*, 1920).

1301. Q.—What kind of application occurs if the train breaks in two?

A.—Electric emergency on the head end and pneumatic emergency on the rear.

1302. Q.—What is the object of electric emergency?

A.—To have the brake action transmitted quicker than the slack in the train can change.

1303. Q.—Can the brake be applied with an angle cock closed?

A.—Yes, if the brake system of the cars

has been sufficiently charged for an application before the cock was closed.

1304. Q.—Can the brake be released back of the closed angle cock?

A.—No.

1305. Q.—What would occur if the electric current should fail en route?

A.—When the brake valve handle was placed in service position, the brake valve equalizing piston would lift and discharge brake pipe pressure in the usual way.

1306. Q.—Would the valve handle then be moved to release position and back to holding after the desired reduction is made?

A.—No, the discharge from the service part of the brake valve would signify that the electric brake had failed, and it would be handled as is considered good practice with the pneumatic brake.

1307. Q.—Where are these electric contacts made?

A.—In the drum at the top of the brake valve.

1308. Q.—The same position being used for both pneumatic and electric operation, they may be termed as what?

A.—Interlocked.

1309. Q.—How is the brake valve handled after an emergency application intentional or accidental?

A.—It is left in emergency position until the train has stopped.

1310. Q.—What is the result of making an emergency application and attempting to release and get away without a stop?

A.—Usually a delay.

1311. Q.—In what way?

A.—The quick action valves have the brake pipe open to the atmosphere to insure a stop, and if the brake valve is moved to release position the excess pressure will be lost through the open brake pipe and there will be a failure of brakes to release until they are "pumped off."

1312. Q.—Does this also apply to pneumatic operation of universal valves?

A.—Yes, the brake pipe is open to the atmosphere for at least 10 or 12 seconds after the quick action valves have opened.

1313. Q.—Why is the brake pipe pressure exhausted into the brake cylinder from the service magnet valve?

A.—To prevent an over-reduction in brake pipe pressure.

1314. Q.—How is it prevented?

A.—When brake pipe and brake cylinder pressures become equal, no further brake pipe reduction can be made.

1315. Q.—Can the brake then be applied in quick action and full emergency brake cylinder pressure be obtained?

A.—Yes, by placing the brake valve in emergency position or opening a conductor's valve.

1316. Q.—Why is an over-reduction in brake pipe pressure undesirable?

A.—It wastes brake pipe pressure, and thus at times tends to prevent an otherwise prompt release of brakes.

1317. Q.—What is to be done in the event of any undesired operation of the electric feature?

A.—The brake switch in the cab is to be opened and the brake operated pneumatically.

1318. Q.—And if the trouble still exists?

A.—Open battery switch on head car at end of battery box.

1319. Q.—And if it still exists?

A.—Examine the rest of the cars to see that all switches are open.

1320. Q.—If trouble still existed?

A.—It would indicate that the disorder is in the pneumatic brake.

1321. Q.—As to a comparison of the brake valve positions when electric current is employed, release position?

A.—Same as pneumatic, except that car brakes will not release.

1322. Q.—Running position?

A.—Same as pneumatic except only position in which car brakes can be released.

1323. Q.—Holding position?

A.—Same as pneumatic, except that car brakes are held applied.

1324. Q.—Lap position?

A.—Exactly same as pneumatic.

1325. Q.—Service position?

A.—Same as pneumatic, except brake pipe pressure is vented into the brake cylinder of each car instead of being exhausted from the brake valve.

1326. Q.—Emergency position?

A.—Same as pneumatic, except that brake pipe pressure from the emergency piston chamber is discharged at each universal valve instead of from the automatic brake valve and quick action valves.

1327. Q.—What is the sole object of operating air brakes with electric current?

A.—To avoid objectionable slack action between cars during a brake application.

1328. Q.—And if the brake is applied in emergency by opening the conductor's valve on the rear of the train?

A.—There is no rapid change in slack between the cars even at slow speeds, while with the pneumatic brake this generally results in a break-in-two of the train.

Car Brake Inspection.

(*Continued from page* 212, *July*, 1920).

1240. Q.—Can the brakes be applied with a closed angle cock in the train?

A.—Yes, if the brake system of the cars are charged.

1241. Q.—Why will they fail to release back of the closed cock?

A.—Brake pipe pressure cannot be increased to move the universal valves to release position.

1242. Q.—What if the brake would not operate correctly with the electric features?

A.—The electric feature would be cut out and the brake tested and operated pneumatically.

1243. Q.—How is it cut out?

A.—By opening the battery switch that was closed on the first car.

1244. Q.—What would be done if some trouble still existed?

A.—The remaining cars would be examined to see that all switches were open.

1245. Q.—What if brake trouble still persisted?

A.—It would be in the pneumatic feature and would be located in the usual manner.

1246. Q.—What should be done in making up a train that had several cars without the electro pneumatic brake?

A.—They should be placed on the rear end of the train.

1247. Q.—For what purpose?

A.—So that the head portion could be electrically operated.

1248. Q.—Would there be any change in the brake test?

A.—Yes, by arrangement with the Engineer two release signals would be given and he would handle the brake valve accordingly.

1249. Q.—When would the first release signal be given?

A.—After the cars with strictly pneumatic brakes had been examined to see that all are operating properly.

1250. Q.—And the second release signal?

A.—After the electrically operated brakes have been examined.

1251. Q.—And after the second signal?

A.—Brakes are to be examined to see that all have released.

1252. Q.—What should be done if the electric operation of the brakes is correct, but the electric signal does not respond?

A.—If the signal line is charged, the Engineer should be requested to close the stop cock in the electric signal supply and open the stock cock in the pneumatic signal supply.

1253. Q.—And the communicating signal should then operate?

A.—Pneumatically.

1254. Q.—What could be wrong if there was no disorder when the brakes were being tested pneumatically, but after the engine coupled and the electric brake was cut in, a blow developed at the brake cylinder exhaust port of one of the universal valves?

A—It would indicate that the service magnet valve of the universal valve was leaking.

1255. Q.—What is the effect of this after the brake is applied?

A.—The leaky magnet valve continues the brake pipe reduction until brake pipe and brake cylinder pressure on this car have equalized.

1256. Q.—What would be the effect of a leaky emergency magnet valve?

A.—A blow of air from the exhaust port of the emergency magnet valve.

1257. Q.—Wh . kind of a leak would this be?

A.—A brake pipe leak.

1258. Q.—What could be done if either one of these valves were leaking badly enough to interfere with the operation of the brake?

A.—Either one or both can be cut out.

1259. Q.—How?

A.—By means of the magnet valve cut out cap in the electric portion.

1260. Q.—What is the normal position of this cap?

A.—With the lug or indicator pointing upward.

1261. Q.—How is the service magnet cut out?

A.—By loosening the holding nut and turning the lug to point toward the service magnet valve.

1262. Q.—And the emergency magnet valve?

A.—Is cut out when the lug points toward it.

1263. Q.—And both are cut out?

A.—When the lugs point downward.

1264. Q.—Will cutting out the service magnet valve prevent the operation of the brake on this car?

A.—No.

1265. Q.—How will the brake pipe reduction necessary to apply the brake be obtained?

A.—From the brake pipe direct.

1266. Q.—And made by?

A.—The other universal valves in the train.

1267. Q.—Can the release magnet valve be cut out?

A.—No, there is no necessity for it.

1268. Q.—Why not?

A.—The normal position of this valve is open.

1269. Q.—Is this the most efficient brake yet developed?

A.—Yes, for steam road service.

The Corrosion of Steel.

A number of years ago Dr. Allerton Cushman promulgated the electrolytic theory of corrosion, which is now generally accepted as the scientific explanation of the phenomenon. It is based upon the proposition that a metal whose structure is homogeneous has no tendency to set up electric currents under the influence of moisture and therefore in such a metal electrolysis and corrosion does not occur. On the other hand, where the structure is not homogeneous such currents are set up under favorable conditions and corrosion occurs with greater or less rapidity according to the degree of this lack of homogeneity. According to this theory, perfectly pure and homogeneous iron should be rustless, and it is, if samples of such metals that have been exposed to the atmosphere for hundreds of years can be taken as corroborative testimony.

When the theory was first developed an attempt was made to manufacture a very high grade, pure iron that should be rustless, and the attempt succeeded, so far as analyses showed. In making the early analyses of this metal it was only analyzed for the usual impurities of carbon, manganese, sulphur, phosphorus and silicon, and a total of only a very small fraction of one per cent. of all of these impurities was found. The metal immediately took a ranking position for its rust-resisting qualities.

But later and more comprehensive analyses showed that it did contain traces of oxygen and small percentages of copper. This determined, the manufacturers, in their attempts at purity, tried to eliminate the copper and partially succeeded, but copper is a difficult impurity to get rid of. At the same time other manufacturers scoffed at the purity feature and claimed that it was the copper which did the trick and straightway put a copper-steel upon the market for which great rust-resisting qualities were claimed.

Now comes a disagreement of the doctors. The pure metal advocates base their claims for the excellence of their product upon purity and homogeneity, as called for in Dr. Cushman's theory. But some outsiders say that they do not think that the metal has such high rust-resisting qualities with the copper cut to, let us say, an irreducible minimum as it was when it was present in an appreciable quantity. At the same time, these same critics say that if the makers of copper-steels would take more pains in the refinement of their metal and so produce a more homogeneous structure, they would have something with far greater resistance to corrosion than they have now.

In other words, they believe that copper in steel serves as a preventive of corrosion, but they still pin their faith to the electrolytic theory, which demands that a rust-resisting metal must be homogeneous. In short, put in the copper and make the metal homogeneous, and you have done the best that the modern science of steel making can do to make a rust-resisting metal.

It is, perhaps, rushing in where angels fear to tread, but the last report of the committee on corrosion of the American Society for Testing Materials seems to bear out this copper-homogeneity contention. The report, to be sure, draws no conclusions, as the tests upon which it is based have not been concluded, but they have now been under way for four years, and the indications point in the direction indicated. A large number of sheets of base metal of various kinds have been exposed to the atmosphere at Pittsburgh, Fort Sheridan and Annapolis. The atmospheres being respectively the acid one of a great industrial center, near a large body of fresh water and near the salt water. The sheets are of pure iron, puddled iron, acid and open hearth steel and Bessemer steel, both copper and non-copper bearing, some purchased in the open market and others especially made for the test.

The acid conditions of the atmosphere at Pittsburgh are the most severe of the three points, and it is to the results obtained at these places that reference is here made.

The sheets exposed were of two gauge thicknesses, numbers 22 and 16. They were divided into copper and non-copper bearing according as they contained 0.15 per cent. of copper more or less. Those of 0.15 per cent. and more being considered copper bearing; those of less as non-copper bearing. There were 146 sheets of copper-bearing metal of 22 gauge, and 132 of the 16 gauge; and 84 non-copper bearing of the 22 gauge and 126 of the 16 gauge.

At the end of 41 months' exposure out of the 146 sheets of copper-bearing steel of No. 22 gauge, 42 or 28.77 per cent. had failed, while the failure of the non-copper bearing sheets of the same thickness amounted to 81 or 96.66 per cent. And, furthermore, the three sheets of this series that did not fail were of the same set and held 133 per cent. of copper, which was just enough below the arbitrary limit set to have them classed as non-copper bearing; the copper content of their failing fellow sheets having been about .0025 per cent.

Of the No. 16 gauge copper-bearing sheets there were no failures, while of the non-copper bearing there were 33 or 26.19 per cent.

It has been urged before the society that results of exposure tests under different atmospheric conditions do not always check, and it can hardly be expected that identical results will be obtained at each of the three places where these tests are being conducted. Nor is it probable that each and every one of the sheets tested possesses the same degree of homogeneity. But when we find that of 14 sheets of specially made copper-bearing, open-hearth and Bessemer steels none had failed at the end of 41 months, while of 9 sheets of non-copper-bearing similar steels, especially made by the same firm, had all failed; when such conditions exist, the layman who wants results at the earliest possible date is warranted in the conclusion that the indications are that copper in steel has a tendency to give it rust-resisting qualities. As for the quantity of copper the average amount in the 14 sheets just cited was 0.369 per cent., while the 9 non-copper sheets contained an average of 0.046 per cent. The other impurities were fairly constant and equal.

The committee, of course, is quite justified in refraining from making any recommendations or drawing any conclusions until the tests are finished, and they have given no public expression of opinion, but it would seem that the results of this elaborate test, thus far obtained, would warrant the trial, on a commercial scale of copper-bearing steels of homogeneous structure where rust-resisting qualities are especially desirable.

Details of Parts of the Pacific Type Locomotive as Shown in Our Chart, No. 12

Cylinders, Saddle and Steam Chests.

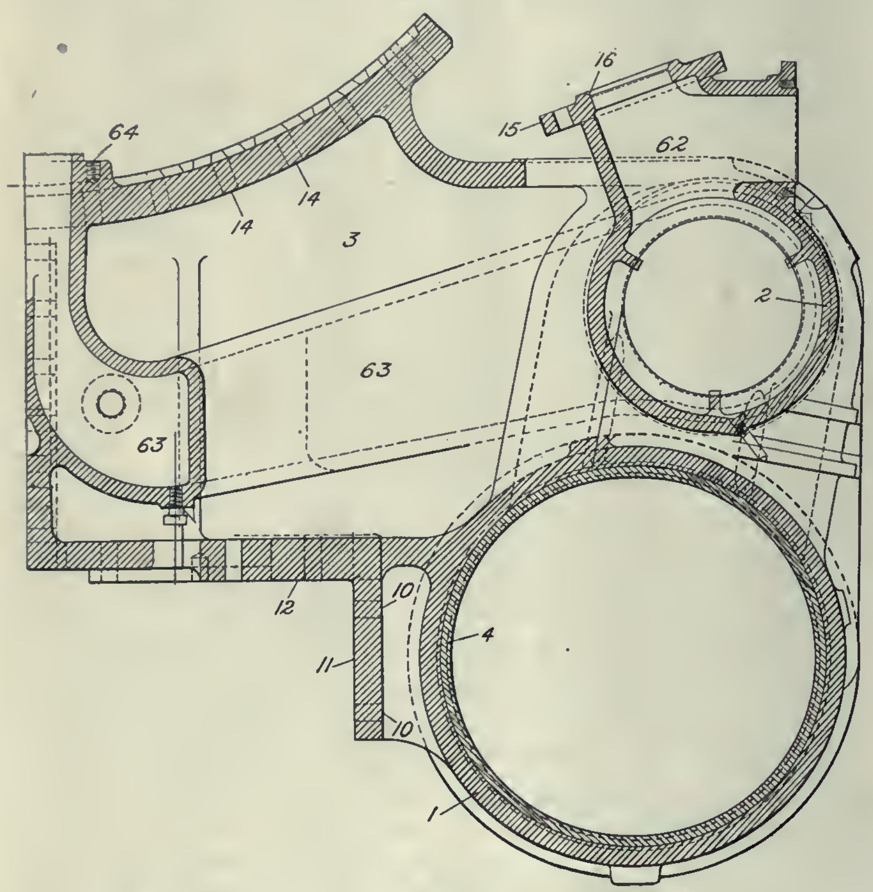
The accompanying drawings illustrate the construction in detail of the cylinder and its connecting parts as shown on the chart of the Pacific locomotive.

The cylinder (1), the steam chest (2) and the half saddle (3) are cast in one piece which is the present American practice. By properly designing the pattern, as was done in this case, one serves for making the castings for both sides of the engine and rights and lefts are unnecessary.

The main casting is of steel and as this material does not make a good bearing surface the cylinder is lined with a bushing (4), as is also the steam chest with a bushing (5). These bushings are of cast iron, and are finished all over and pressed into place, usually with a light hydraulic or screw press. In the steam chest bushing the steam ports (6) are cut before the bushing is pressed into place. The same holds true of the cylinder bushing ports (7). Both of these register with the main steam ports (8) in the cylinder casting. The steam chest bushing is held in place by the set stud (9) and that of the cylinder by a similar screw and stud which is not shown in the engraving.

The cylinder and half saddle casting is fastened to the frame by bolts passing through the holes (10), and the vertical frame face (11), as well as the horizontal face (12) are planed to receive the frame. The smokebox rests upon the curved smokebox seat (13) whose upper surface is cast to the same radius as that of the smokebox, and then shipped to fit the same. When the two pieces are together they are held by rivets driven through the rivet brake (14).

There is one more outside connection of this casting and that is to the steam pipe. This is made at the flange (15) which is bolted to a corresponding flange on the steam pipe. Between the two a ball is placed which has its seat on the ball seat (16).



CROSS SECTION OF CYLINDERS, SADDLE AND STEAM CHEST

The cylinder contains the piston (17), which is made up of the piston head (18) and the piston rings (19). The head is usually a steel casting of a dished form and the piston rings are of cast iron made in a single piece, and split so as to be sprung into grooves cut in the piston head. The piston is pressed upon the piston rod (20) and further held by the nut (21) from working off. The piston rod extends out through the front end of the cylinder and ends in the crosshead seat (22). The piston rod is extended to the front and forms a tail rod (23), which runs through the front cylinder head (24) and is attached, at its end, to the tail rod crosshead (25), which is held in place by the tail rod crosshead nut (26). This crosshead has a bearing and rests upon the tail rod crosshead guide (27). This carries the tail rod and together with the main crosshead supports the piston and piston rod and relieves the rod packing from the weight of the parts and the wear to which it would otherwise by subjected. Likewise the cylinder bushing is only subjected to that pressure resulting from the tension of the piston packing rings.

The front end of the cylinder is closed by the front cylinder head (24) which is a steel casting and is held in place by the cylinder head studs and nuts (28). The cylinder head is also dished so as to conform to the contour of the piston and thus reduce the clearance space to a minimum. The front of the cylinder head is in a cylindrical shape to form the stuffing or packing box (29). This contains the metallic packing by which the escape of steam around the rod is prevented. The packing is so designed that it is held tight by the tension of its own spring and cannot be adjusted from the outside. The same type of packing (the R. I. C.) is shown as applied in both heads and the valve stem (30), and so the same description and nomenclature applies to all three. The parts outside of the stuffing box consist of the swab holder (31), which is made of malleable iron; the swab cup (32) made of aluminum; the gland (33) of cast iron; the copper wire gasket (34). Within the stuffing box there is the vibrating cup (35) of cast iron, and the vibrating cup bushing (36), also of cast iron. Then comes the packing bridge ring (37), the packing bevel ring (38), both of which are of brass; then the spring follower (39) of cast iron and the spring (40). In the case of the valve stem, the spring has a bearing against a brass bushing (41) that relieves the packing of any weight that might otherwise be put upon it. But in the case of the piston and tail rods, they pass through the heads without touching, since the weight of the moving parts is carried by the crossheads at either end.

The back end of the cylinder is closed by the back cylinder head (42), which is dished in the opposite direction from the front head and for the same reason. This head is held to the cylinder by studs and nuts (43) and the joint between it and the cylinder is made by grinding as in the case of the front cylinder head and steam chest heads. The back cylinder head is also of cast steel and has the guide bracket (44) cast integral with it. Both cylinder heads are cored and threaded (45) for drifting valves.

Into the bottom of the cylinder at each end the cylinder cocks (46) are screwed. These cocks are directly operated by the cylinder cock slide rod (47), which, in turn, is moved by the cylinder cock shaft arm (48). This shaft arm is keyed to the cylinder cock shaft (49) which has bearings in the cylinder cock shaft bracket (50) which, in turn, is bolted to the cylinder casting. Projecting upward from and keyed to the cylinder cock shaft, on the right hand side of the engine, is the cylinder cock lever (51), to the upper end of which the cylinder cock reach rod (52) is attached. This rod runs back to the cab where it terminates in a suitable handle for manipulation by the engineer.

The arrangements at the steam chest are much simpler. The front end is closed by a simple head (53) which, as in the case of the cylinder heads, is held in place by the studs (54) and nuts, and the back steam chest head (55) is of the same general design as the corresponding cylinder head and carries the same type of packing.

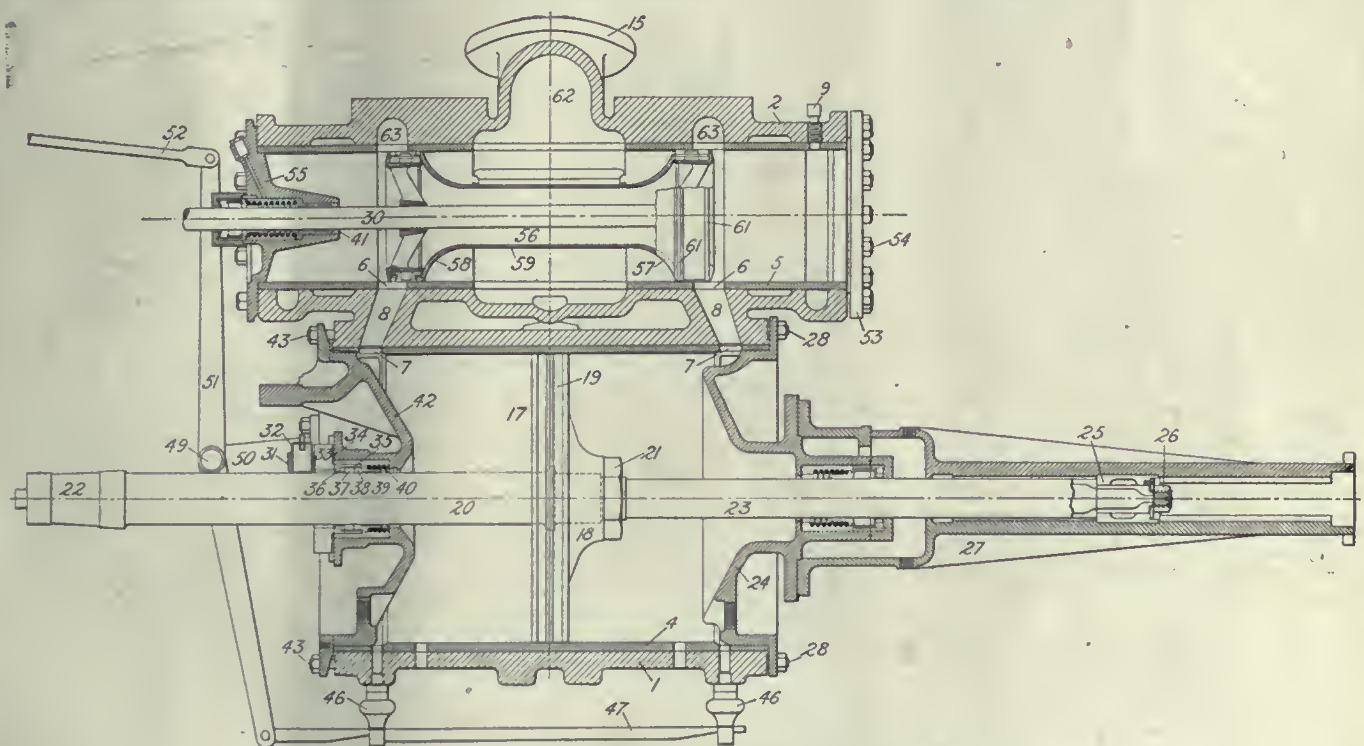
The valve (56) is formed of three parts: the front head (57), the back head (58) and the body (59). The two heads are steel castings and the body or piece of pipe welded to and attaching the heads together, thus forming the single rigid structure of the valve.

Each head is fitted with a cast-iron bull ring (60) into which the packing rings (61) are fitted in the same way as the packing rings are fitted to the piston.

In the design shown, the steam enters the steam chest through the steam passage: (62) to a point at the center between the valve heads. From here it is admitted to the cylinders and is exhausted at the ends of the steam chest, both of which are in communication with each other through the center of the valve.

The exhaust leaves the steam chest through the exhaust passages (63), which come together at the center and are led up to the exhaust pipe, which is bolted to its seat (64).

The following is a list of the parts of this portion of the locomotive.



LONGITUDINAL SECTION OF CYLINDER AND STEAM CHEST

List of Parts

1. Cylinder.
2. Steam chest.
3. Half saddle.
4. Cylinder bushing.
5. Steam chest bushing.
6. Steam ports of steam chest bushing.
7. Cylinder bushing ports.
8. Steam port.
9. Steam chest bushing set stud.
10. Bolt holes for cylinder-frame bolts.
11. Vertical frame face.
12. Horizontal frame face.
13. Smokebox seat.
14. Saddle smokebox rivet holes.
15. Steam connection flange.
16. Steam ball joint seat.
17. Piston.
18. Piston head.
19. Piston rings.
20. Piston rod.
21. Piston nut
22. Crosshead seat.
23. Piston tail rod.
24. Front cylinder head.
25. Tail rod crosshead.
26. Tail rod crosshead nut.
27. Tail rod crosshead guide.
28. Cylinder head studs.
29. Front cylinder head stuffing box.
30. Valve stem.
31. Q. & C. packing swab holder.
32. Q. & C. packing swab cup.
33. Q. & C. packing gland.
34. Q. & C. packing copper wire gland gasket.
35. Q. & C. packing vibrating cup.
36. Q. & C. packing vibrating cup bushing.
37. Q. & C. packing bridge ring.
38. Q. & C. packing bevel ring.
39. Q. & C. packing spring follower.
40. Q. & C. packing spring.
41. Back steam chest head bushing.
42. Back cylinder head.
43. Back cylinder head stud.
44. Guide bracket.
45. Drifting valve thread.
46. Cylinder cock.
47. Cylinder cock slide rod.
48. Cylinder cock shaft arm.
49. Cylinder cock shaft.
50. Cylinder cock shaft bracket.
51. Cylinder cock lever.
52. Cylinder cock reach rod.
53. Front steam chest head.
54. Front steam chest head stud.
55. Back steam chest head.
56. Main valve.
57. Front head of valve.
58. Back head of valve.
59. Valve body.
60. Bull ring.
61. Valve packing ring.
62. Steam passage.
63. Exhaust passage.

Railway Operation and Maintenance Under a Divisional Organization

At a meeting of the Central Railway Club at Buffalo, N. Y., recently, Alfred Price, General Manager of the Canadian Pacific Railway, read a paper on the above subject in the course of which, after tracing the growth and early development of the American railroad systems, he stated that—"of the many railway associations in existence to-day the most important, although not the oldest, is the American Railroad Association, which was organized in 1872, its object being 'the discussion and recommendation of methods for the management of American railways.'" Probably the oldest organization of the kind is the Master Car Builders' Association formed in 1867. Its objects are "The advancement of knowledge concerning the construction, repair and service of railroad cars to bring about uniformity and interchangeability in their parts and to adjust the mutual interests growing out of their interchange and repair."

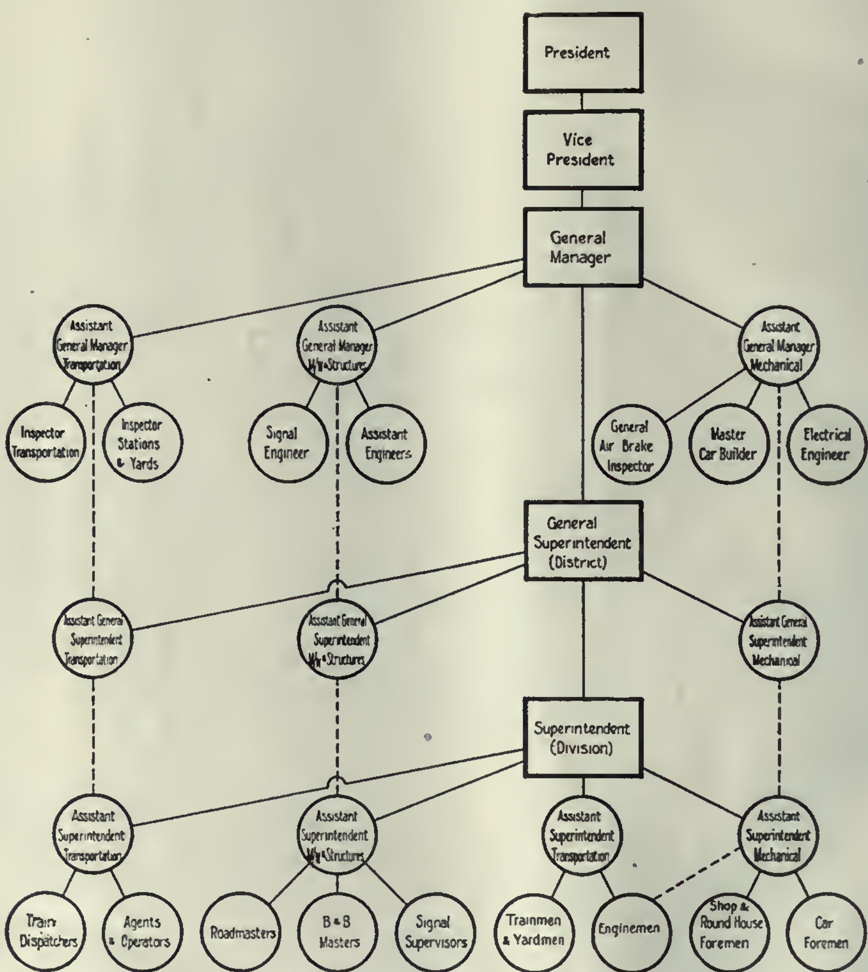
There are also important associations representing all branches of railway work, including Maintenance of Way, Car Service, Railway Telegraph, Railway Signal, Passenger Traffic, Freight Traffic, Accounting, Baggage, Stores and Claim Agents—who discuss and legislate upon the various matters over which they respectively have jurisdiction. Through the recommendations and decisions of these associations agreements have been reached on almost every known railway subject and almost every article used in connection with railroad construction, maintenance and operation.

Upon one subject, however, no agreement has ever been arrived at. Both the Divisional and Departmental organizations are in effect upon railroads that are known to be efficiently and economically managed and neither system is without its champions. It is believed by some successful railroad executives that the Maintenance of Way Department should be under the direct supervision and sole control of men who are technically trained engineers and that the track and bridge maintenance should be something entirely separate from the operation of the railroad. Similarly it is their opinion that the Mechanical Department should be managed exclusively by men having had a thorough mechanical training and that there should be a well defined line of demarcation between it and the Operating Department. The theory is that in this day of specialization the right principle is to have experts in sole charge of the three important departments—Operating, Maintenance of Way and Mechanical—and that they should be handled as separate entities.

The Departmental idea is carried a great deal higher up on some roads than on others. In some cases the General Superintendent besides being in charge of operation controls all maintenance and mechanical work on his District, the officers of these departments reporting direct to him. In other cases the departments are kept entirely separate on Districts, as well as on Divisions, and the Departmental officers report direct to the General Manager. Again on other roads a great gulf is fixed between the working forces in the different departments, the General Manager having no control of maintenance of way and mechanical matters. Instead the Departmental officers have supreme authority over their respective departments and report direct to the Vice-President in charge of operation and maintenance.

The absolute necessity of having highly trained experts supervise these two technical departments is fully appreciated, but this is quite possible under a system that will co-relate under the Divisional Superintendent all the forces of the Operating, Maintenance of Way and Mechanical departments so as to make them complementary to one another.

Instead of designating the departmental officers as "Assistants" some would prefer to use the old familiar titles, such as Superintendent Transportation, District Master Mechanic, Division Engineer, Trainmaster, Chief Despatcher, etc., but this is not material.



RAILWAY OPERATION AND MAINTENANCE UNDER A DIVISIONAL ORGANIZATION

The Assistant General Manager (Maintenance of Way) prescribes standards in connection with track, bridges and buildings; allocates new rails supplied for replacement; passes upon all plans submitted to the General Manager by General Superintendents for approval; criticizes maintenance of way expenditures, etc., etc.

The Assistant General Manager (Transportation) is responsible for the distribution of cars as between Districts;

the preparation of timetables, fixing the time of through trains at inter-district points; the issuance of instructions about preference freight and special passenger train movements; notices of embargoes; criticizes transportation expenses, etc., etc.

The Assistant General Manager (Mechanical) is responsible for the distribution of power as between Districts; he prescribes locomotive shop, car shop and roundhouse practices; controls the movement of air brake inspection cars; supplies dynamometer car and attendants for the making of tonnage rating tests; criticizes mechanical department expenses, etc., etc.

All three officers report to the General Manager and all instructions to district officers are addressed to the General Superintendents over the signature of the General Manager.

The three Assistant General Superintendents bear pretty much the same relation to their General Superintendent as the three Assistant General Managers bear to the General Manager, communications and instructions being sent out over the signature of the General Superintendent. They confer with officers of higher rank on work in which they are specially concerned and guide those of lower rank so as to ensure the work being prosecuted in accordance with the prescribed standards and practices.

The Assistant Superintendents report direct to their Superintendent. They bear pretty much the same relation to him as corresponding officers of high grades bear to the General Manager and to the General Superintendents. They are held directly responsible to him for the work of the men under them and have the advantage of the assistance and advice of the District officers in the same departments.

Such a system absolutely removes any departmental friction and tends to promote harmony throughout all branches of the service. If passenger trains fail to maintain their schedules, the Superintendent is not in a position to blame the Engineering Department for not keeping the track in proper condition for high speed trains, nor the Mechanical Department for not maintaining locomotives in condition to make time. He is responsible for the condition of both the track and the power.

When there is an abnormal demand for engines for work train service as well as for traffic, the Superintendent being in full control and responsible alike for the track maintenance and the traffic movement is in a position to decide in what proportion the available power should be provided for each class of service.

Engines turned out for traffic can, when necessary, be utilized to do odd jobs of maintenance of way work, such as unloading cinders or ties en route and likewise engines supplied for work train service can often be utilized to handle revenue traffic before reaching working limits or beyond them.

When a division of railway is required to take care of some extraordinary rush of traffic, so that the facilities and power are taxed to their utmost, if the Superintendent finds that a few extra men in the roundhouse or at the ash pit or coaling plant would result in a quicker outturn of engines he is in a position to authorize their employment—or to transfer them from some other class of work.

When there is an accident—and no railway is immune from such unfortunate occurrences—it is very much better to have one man responsible for clearing the line, repairing the track, picking up the wreckage and resuming the running of trains than to place the responsibility of clearing the line and picking up the wreckage upon the Mechanical Department and for repairing the track upon the Maintenance of Way Department, while the Superintendent's forces stand aside waiting for the other departments to repair the damage and make the line passable for the resumption of traffic.

In an investigation to determine upon whom to place responsibility for an accident, the Superintendent can have no object in attempting to fix the blame, except where it belongs. Under a Departmental organization, all departments interested are represented and every representative naturally desires to escape the necessity of admitting responsibility. This is unfortunate, but as human nature is constituted, it is inevitable.

A Superintendent has a greater number of officers available for special emergencies. If it is suspected that men engaged in train service are becoming lax in the observance of any of the important general rules or if it is considered advisable to check up any feature of track work, he is in a position to use all his assistants for checking or efficiency testing. There is an added advantage in that so many assistants obtain a general all around knowledge of and experience in the operation and maintenance of a division fitting them for greater responsibilities.

Not the least important benefit to be derived from a divisional organization is the broader training which officers in the lower positions receive. A man occupying the position of General Manager or General Superintendent should not only know something theoretically but a great deal practically about the maintenance of track, buildings, bridges, signals, cars and locomotives, besides being a competent transportation officer, and the best way to acquire this general knowledge is to be placed in a position to gain the practical experience. A Superintendent given such an opportunity will naturally make a more capable general officer than one whose training is confined to one department of railroad work.

It has already been stated that some railroads are being efficiently and economically managed under a Departmental organization. The question naturally arises "Would still better results be produced under a Divisional organization?"

The Relation of the Hammer to Punches and Chisels.

In all cases there must be some relation between the size of the tool and the weight of the blow struck, and to use, say, a 7 lb. hammer on a 3/8 in. punch or chisel would mean the smashing up of the tool with very little effective result in the way of work. It may be shown as a ready example of this that while you can drive a 16-gauge 2 in. wire nail into an ordinary brick until its head is flush, if you use a 4 oz. to 6 oz. hammer, yet if you use a 2 lb. hammer the nail will not enter, but simply collapse; in effect this is the same with all percussion tools. If you have a big-bodied chisel or punch you can use a sledge hammer on it, but if you have a small-bodied tool only a small hammer can be effectively used, and for the usual 1/2 in. to 5/8 in. hexagon steel punches and chisels more work can be done with a 3/4 lb. to 1 lb. hammer than with one of larger size, owing to more of the force being utilized.

Holiday Railroad Service

It does not require a trip across the Continent to see that something like old time railroad efficiency is showing itself in emergencies. In the holdiay season, when the dwellers in cities take to the woods, the experience of recent years has been something that we should try to forget. This year the traffic is enormous and the railroad men are meeting the situation admirably. The trains are not only on time but even the accommodation is all that can be desired, and no further proof is necessary that those engaged in transportation service are buckling down to their work in earnest. To this must be added the fact that there was no disaster to speak of, and, although the equipment must have been strained to the breaking point, nothing broke. This is as it should be and as it will be if the Governmental Commissions and Labor Boards could be inspired with the electricity of action and not linger over their work until disputants are wearied and driven to exasperation. The spirit that called forth millions of young men to battle for the right can be maintained in the acts of peace if the leaders acquit themselves like men and not like graven images.

It must be admitted, however, that the action of the Interstate Commerce Commission has shown a degree of activity in reaching its decisions in regard to the rate question that it is a good example which we hope will be followed in the future.

Electrical Department

Electric Locomotive Control—(Continued)

In locomotive operation it is very necessary to have extremely smooth acceleration from start to maximum speed where heavy trains are handled. Surges will result in serious damage, and the locomotive control must be designed to give the smooth acceleration. Full trolley voltage cannot be applied directly to the motors at standstill on account of the enormous current which would flow. Sufficient resistance must be placed in series with the motors to hold the starting current down to normal value. There are several ways of connecting in the resistance. The easiest way, as described and illustrated in last month's article, is to correct the two motors permanently in the full speed position and then provide sufficient resistance to keep the first current rush down. When all the resistance is cut out the motors are running across the full voltage. This arrangement is known as rheostatic control, the resistance being connected in three ways; namely, series, parallel, and a combination of the two.

With the motors connected in parallel permanently, there is considerable power lost in the resistance in the form of heat. Economy can be obtained by connecting the motors in combinations. Less resistance is required and there is less loss in the resistance. It is true that smooth operation is obtained but there is the objection due to the economy.

Locomotive equipments include an

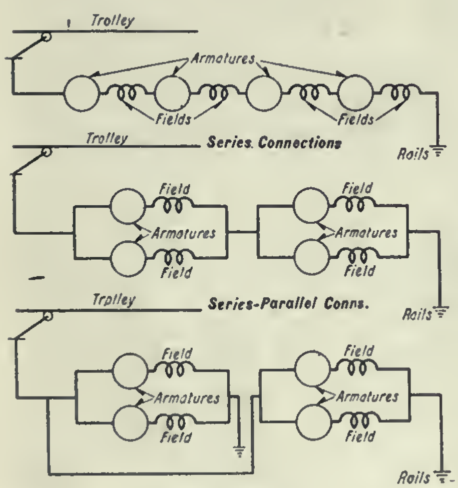


FIG. 1—MOTOR COMBINATIONS

even number of motors and the minimum is generally four. However the number may be as high as the design permits, the Chicago, Milwaukee & St. Paul locomotive containing twelve. Again, a special design may have only two, as the large and powerful locomotives operating out of the Pennsylvania Tunnel, New York.

To gain the maximum saving in power consumption the combination will be as shown in Fig. 1, the motors being connected first in series, then in series parallel, and finally in parallel.

In smaller locomotives of 80 to 100

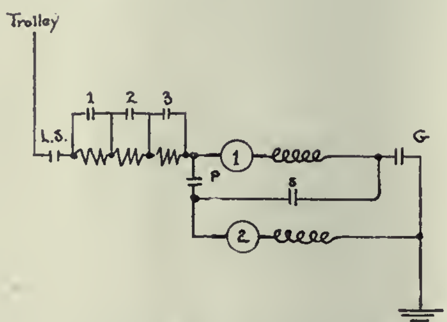


FIG. 2—DIAGRAM OF OPEN CIRCUIT AND SHUNTED MOTOR ARRANGEMENTS

tons or less the first arrangement with all four motors in series, is generally omitted and the locomotive starts with the motors in the series parallel arrangement, with two motors connected permanently in parallel and controlled as one unit.

The problem of changing from one motor combination to the other and still obtain smooth acceleration is somewhat different than the series method of resistance control. With rheostatic control the circuits are simple (as illustrated in the previous issue) but with the motor combinations the circuits are more complicated. Means must be provided to make the transition from series to parallel.

The changing from series combination of motors to parallel combination can be made by three methods namely, the *open-circuit* method; the *shunted motor* method; and the bridging method. In locomotive work the bridging method is used as the smoothest in operation. While in locomotive work the first two mentioned methods are not used they will be referred to as a matter of interest.

The *open circuit* method is shown by Fig. 2. On "transition" when the motors are changed from the series combination to the parallel combination, the circuits are broken. That is, after all of the resistance is cut out with the motors in series, the power is cut-off the circuits, then changed so that the motors will be in parallel, and the power applied again with the resistance back in the circuit. During the open circuit the motors are developing no torque and hence there is a falling off in speed. Naturally there would be a surge when the power comes on again, so that this arrangement is not satisfactory for locomotive work. Referring to Fig. 2. the switches closed for full series operation would be LS, 1, 2, 3, and S. To get the two motors in parallel switch LS is opened and then switch S. Switches P and G are then closed, the two motors are connected in parallel, and then the LS switch closes. The resistance switches had opened with the S switch so that all the resistance would be in the circuit and could be cut out as the speed increases.

The same diagram shows the shunted-motor method. As the name implies one motor is shunted during transition. The method has a distinct advantage over the open circuit method in that only one-half of the torque is lost during transition. One motor is working and the locomotive would not lose its draw-bar pull entirely. Referring to the Fig. 2 the full series will be the same. The switch LS is not opened and power is not cut off. The resistance is cut in, however, by opening the switches 1, 2, and 3, and an instant later switch G is closed allowing the current to pass through No. 1 motor, and shunting it around the No. 2 motor. Switch S is opened and then P closed and the motors are in parallel.

With the bridging method the power is not cut off from either motor nor is either motor shunted. The great advantage of this method is that all motors are

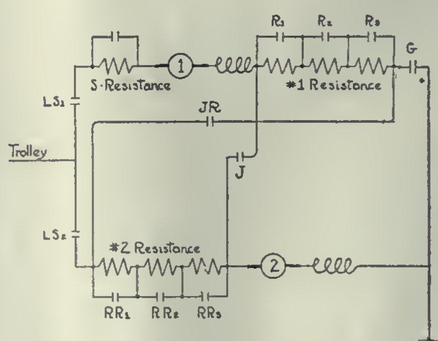


FIG. 3—BRIDGING METHOD CIRCUIT ARRANGEMENTS

working during transition and smooth acceleration is obtained. The circuits are shown by Fig. 3.

Referring to Fig. 3, on the first step the switches LS and JR are closed. The motors are in series and all of the resistance is in the circuit. On the next step S closes and then the switches R_1, RR_1; R_2; RR_2; R_3 and RR_3 are closed consecutively and then switch J. After J closes all of the resistance switches except S open. The bridging now follows. Switches LS_2 and G are closed. Disregarding for a moment the motors there is a circuit from the trolley through LS_2, No. 2 resistance, J, No. 1 resistance and G to ground. The circuit through the motors is from the trolley through LS_1, No. 1 motor, J, No. 2 motor to ground. There

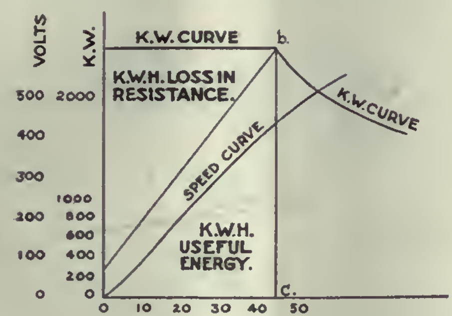


FIG. 4—ENERGY LOSS SERIES RESISTANCE

are thus two circuits established through the J switch which are in opposite directions. The resistances are of such value that when placed across the line the flow of current is practically the same as that taken by the motors in series so that the switch J can be opened without notice as the two currents balance. The switch cannot always be opened exactly when the current is zero as the current through the motors varies with the speed on account of the back electro-motive force but is nearly always the same. The power is in the motors at all times and when the J switch is opened the motors are in parallel.

As mentioned above the energy loss is less when the motor combinations are used. The energy resistance loss for the series resistance with motors permanently connected in parallel is as shown by Fig. 4. This illustration was used in the previous issue and as explained the energy loss in the resistance is 14.6 kilowatt hours. (K. W. H.)

The energy loss in the series parallel arrangement where two sets of two motors each in parallel are used, is shown by Fig. 5. As the two sets are connected in parallel 2,000 amperes will be taken from the line instead of 4,000, but each motor is getting 1,000 amperes and delivering the same tractive effort. With this arrangement 44.4 per cent of the time is taken in series and 55.6 per cent in parallel. The energy loss in series position is

$$\frac{260 \text{ volts} \times 2{,}000 \text{ amperes} \times 20 \text{ sec.}}{3{,}600 \times 1{,}000} = 2.89 \text{ K.W.H.}$$

in the parallel position =

$$\frac{162.5 \text{ volts} \times 4{,}000 \text{ amperes} \times 25 \text{ sec.}}{3{,}600 \times 1{,}000} = 4.51 \text{ K.W.H.}$$

The total loss in the resistance is

$$2.89 + 4.51 = 7.40 \text{ K.W.H.}$$

The useful energy has not changed so that the saving in the total energy input is approximately 25 per cent.

A further reduction in total energy consumed in the resistance can be obtained if the 4 motors are first connected in series. A still further reduction in energy loss can be obtained by field control. The speed of the motor is regulated by varying the effective field turns. Less current is taken during acceleration for a less time on the resistance so that the loss is less. Field control has been used very successfully in the large powerful electric locomotives used on the P. R. R., New York Terminal and also on the new locomotives built by the Westinghouse Company for the C. M. & St. P.

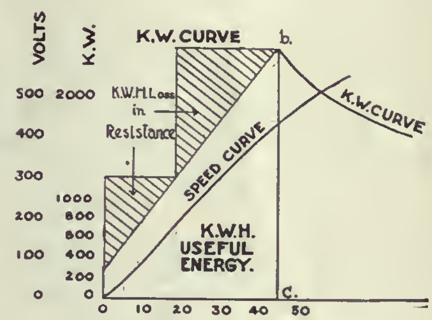


FIG. 5—ENERGY LOSSES SERIES PARALLEL CONTROL

Rail-Creep on Railroad Bridges

Experiments in the case of a railroad bridge in India, where the creep amounted to as much as three to four feet a year, a special cast-iron sleeper was designed to suit the 75-pound flat-footed rail with a jaw large enough to receive a lock-fast steel key. This reduced the creep to insignificance, and generally confirmed the conclusion that "creep" can only be remedied by effective anchorage.

View of the Railroad Situation

While the Association of Railroad Executives has been using eloquent and earnest appeals for a substantial increase in rates, it is also to be observed that the leading manufacturers are joining their voices in the urgent necessity of a liberal treatment of the claims submitted. Among those the Vanadium-Alloys Steel Company, Pittsburgh, Pa., has just issued a frank and sympathetic statement in a booklet containing the enterprising company's views on the subject. As is well known, this company is the manufacturer of the first quality, nationally known, high speed steels, Red Cut Superior, and Red Cut Cobalt, as well as high grade alloy and carbon steels. They frankly state, to use their own words, "We are in no way identified with the railroads or any of their interests. Nevertheless, we are firmly of the belief that the prosperity of not only our company, but American business and the nation as a whole is dependent upon a frank and sympathetic attitude of the whole people to the railroads, and each of us should consider it a privilege to avail ourselves of every opportunity to disseminate proper and correct views as to the true situation in which the railroads find themselves today.

"Wherever men meet, you will always find discussion, and, while avoiding

statistics and figures, we nevertheless feel that the few remarks on this subject will be worth while noting. In a country of more than a hundred million inhabitants it often seems useless to use such influence as we have as individuals to present before a small proportion of the public our views concerning large and vital questions.

A VITAL PROBLEM.

"Our country has many great problems to solve, but the most important is a solution of our present transportation problem. The transportation system of Russia has failed with the result that, although food is plentiful in that large agricultural country, hundreds of thousands in the cities are suffering due to a lack of nourishment. The transportation system of our country is failing. Even today fish are rotting in New England on account of inability to get cans. Potatoes are rotting on western farms on account of not being able to get cars to ship them in. The farmer is awakening to a realization of the fact that it profits him nothing to take care of his stock through winter blizzards, and to sow and cultivate his fields through the summer sun, if when his live stock and his grain are ready to go, there is no transportation to carry them to buyers.

PUBLIC MUST REALIZE SITUATION.

"For years our government has handled the transportation problems in such a bungling and inefficient manner that all advantage of individual initiative has been destroyed. The American public must be brought to realize the seriousness of the country's transportation problem today, to realize that if the railroads are allowed to further deteriorate, and the ratio of people living in the city to people living in the country continues to increase, that the railroads will not be able to transport sufficient food and other products to meet the cities' needs.

NO NECESSITY FOR A PANIC.

"Some business men think that, before the public wakes up to the vital transportation needs of the country, it will be necessary to have a severe panic which will force workers in the city back to the country where food is plentiful. One thing is certain: If our country is to be prosperous, the railroads must receive fair treatment. They must receive compensation for service rendered which is proportionate to that of other industries, and sufficient to provide incentive for individual initiative. It is almost twenty years since Mr. Whitelaw Reid delivered an address at the Founders' Day exercises of the Carnegie Institute in Pittsburgh, selecting as his subject, 'Wherein Lies Its Power?' Mr. Reid brought out that the American system of government was the most expensive and inefficient form of government on earth. The power of the American form of government lay in that it created individual initiative to a greater extent than any other form of government.

PRIVATE CAPITAL BUILT OUR RAILROADS.

"The transportation system of our country, which more than anything else has

made our country powerful, was developed by individual initiative. Practically our entire railroad system as it exists today was projected and established with private capital, whereas in many other lands the railroads are, and have been, subsidized or aided by the government. Ten years ago our railroads led the world in efficiency, and, with few exceptions, in decades gone by progress and prosperity marched side by side with the men who laid the tracks, many of which were laid through thousands of miles of wilderness.

INDIVIDUAL INITIATIVE NEEDED.

"It is an American trait to be optimistic of our nation's future. The country has confronted many difficulties in the past. These difficulties have always been overcome, but they have always been overcome to a large extent by the help of individual initiative.

"In the 'Daily Bulletin,' May 26, 1920, *Manufacturers' Record,* an article appears which is headed, 'It Is No Time for Parsimonious Treatment of the Railroads,' and a few excerpts from this article are worth consideration:

"In February, the last month of Government operation of the railroads, the properties not only failed to earn the $75,000,000 guaranteed by the Government, but they showed, in addition, an operating deficit of $12,000,000. It cost the Government, in other words, $87,000,000 to operate the roads in February, although the volume of traffic handled was the largest of any February since records have been kept.

"The more business, the greater the losses, is a formula of ruin.

"The railroads are now asking for freight increases which will aggregate something more than a billion dollars annually.

"It is going to cost that much to put the transportation facilities of the nation in proper shape. The public might have paid the money through increased taxation, but changing rates, under Government ownership, or it can pay it without increased taxation in the form of additional cost for services rendered.

A SERVICE BELOW COST IS NEVER CHEAP.

"We believe in cheap service, but a service sold below cost is never cheap. It is paid for, and more than paid for, subsequently in other ways. To illustrate, cheap railroad rates drove river transportation lines out of existence and almost ruined the coastwise trade. This system tended not only to bankrupt the roads, but it eventually meant the penalization in service of those communities which had permitted their water connections to disintegrate.

"Good service at a fair price is always more profitable to all concerned than bad service at a low price. Not only is the strain on the credit facilities of the nation magnified by vast quantities of products held stranded on side tracks, but the productive power of the nation is lessened and the profits of business seriously curtailed by slowness of movement. The loss, in other words, resulting from poor service, amounts annually to considerably more than $1,000,000,000, we venture to surmise, vast as that amount is.

"None doubts that the private ownership of railroads is on trial. It involves, we think, more than that, for if the railroads become nationalized the other great industries will also become nationalized, and it will not be long before the civilization we know will be marching arm in arm with disaster towards that bottomless pit into which so many other civiliza-

tions before us have precipitated. For years a public hostility to railroads, carefully nurtured by aspiring politicians, has made the properties the victims of unreasonable burdens. Let us hope that the transportation problem will be solved before it is too late, without serious injury to our future; that nationalization of industry (nationalization of your business and ours) will pass away like a nightmore before the sunlight of common sense. During the past few years all government legislation and activity have been such as to retard individual initiative. As Mr. Whitelaw Reid brought out in his address of almost twenty years ago, in spite of the American form of government's being the most expensive and inefficient, it was the best government on earth, for it brought out to a greater extent individual initiative. The advantage of developing individual initiative far overbalanced

other defects in our form of government.

"Facing the problems confronting the public today, we should take into consideration that the government's mismanagement and inefficiency during the past seven years have taken such form as to attack individual initiative, and that we cannot depend upon this factor to help solve present problems to the extent that it did in the past."

A New Hardness Testing Machine

Details of its Construction and Operation

One of the best known methods of measuring the hardness of metals is that devised by Brinell in 1900. According to this method, a 10 mm. ball in contact with the specimen is loaded with a pressure of 3,000 kilograms, and the diameter of the resulting depression in the specimen is measured. By comparing this measurement with the standard tables, the tensile strength of the material can be obtained, though this is not always desired, as the ball test is so well known that specifications frequently stipulate material to fall within certain depression diameters, such as 4.00 to 4.50 millimetres, or alternatively, specify the standard hardness numbers, which are 228 and 179, respectively, for the above diameters.

It is not yet sufficiently realized that by the aid of this simple ball test, production and supplies can be so readily and simply checked, as to almost completely eliminate errors in qualities and treatments of materials. The steel buyer, for example, should check the various qualities of steel he purchases, but with ordinary tensile or analysis tests this is both a lengthy and costly proceeding. It is always possible, and not infrequently happens, that relatively expensive machine or forge work is put on to material that is ultimately found to be of the wrong quality owing to some error either in the ordering or the supply. Further, with steel requiring special heat treatments, a check should be employed in the machine shops to ensure that the treatment has been correctly carried out before the final operations are resorted to. Every practical man handling work involving the buying, stamping, treatment, machining and testing of steel, can call to mind innumerable instances where the use of an accurate, simple, and portable testing machine of this pressure ball type, would have proved of the highest value.

The usual type of Brinell ball testing machine, with the pump and pressure gauge, is generally well known, but is not readily portable, is fairly expensive to maintain, and requires intelligent supervision, in addition to which its action is not instantaneous. This instantaneous action is a very desirable feature, as the ball test is coming into increasing use for the testing of many small items used in engineering practice, which are produced in thousands, and each of which it is necessary to absolutely check to ensure perfection of manufacture and heat treatment.

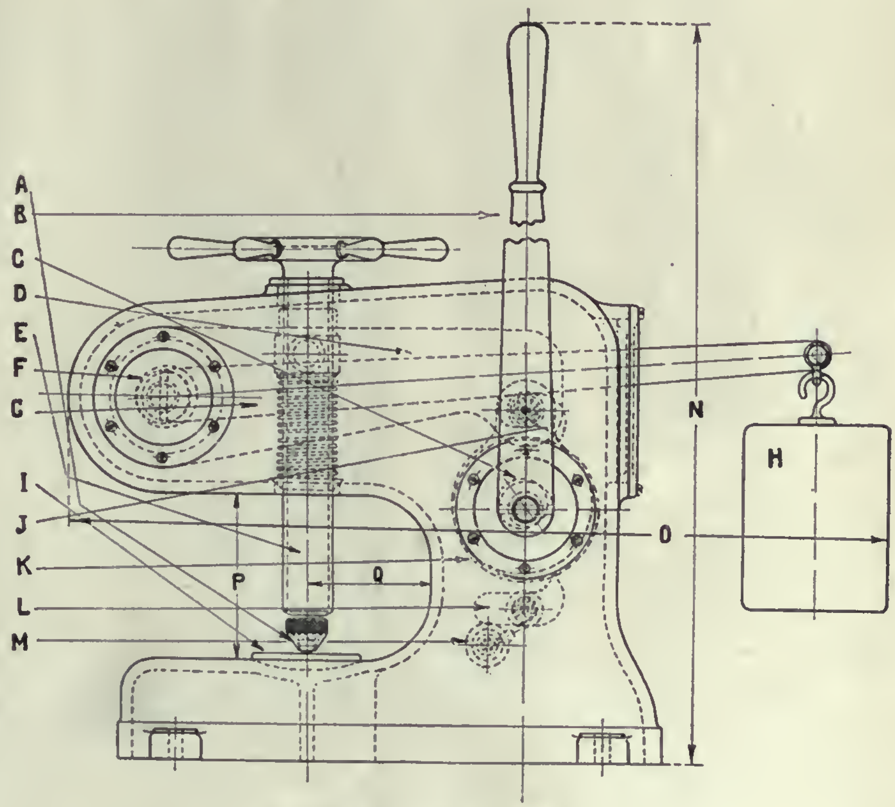
The machine we now illustrate was designed with a view firstly, to give instantaneous action, so that thousands of pieces can be readily passed through it; secondly, to be of a portable character, which considerably increases the works value of the machine, and removes it from its usual stationary position in the research laboratory; and, thirdly, to be of such simple, sound, and practical construction that it could stand rough workshop usage by any class of labor without interfering with its accuracy. It is claimed by Mr. L. Johnson and Mr. H. Brearley, the inventors of this machine, that each of the above points is fully met, and we understand that this is borne out in practice so successfully that large numbers of this improved testing machine are being supplied to leading British industrial plants, who desire quick, simple and accurate methods of checking their products at various stages of manufacture, to ensure uniformity of quality.

This machine consists of a light metal frame carrying the application lever, weight lever and two eccentric shafts, with the necessary small fittings. The eccentric shafts are practically frictionless, as they rotate in Hoffman Roller Bearings. The machine will be readily understood from the description of the methods of operation, in conjunction with the lettered illustration.

The specimen to be tested (which must have a smooth *flat* surface) is placed on the table (I). The adjusting screw (E) is then brought down until the steel ball rests on the prepared surface of the specimen. The lever (B) is then pulled forward until its weight (H) rises allowing the pawl (J) to fall into the toothed sector (K) which will automatically prevent any further movement of the lever (B). The load may be kept on for any desired period by means of the retaining pawl (L) which is moved in and out of position by means of the knurled handle (M). The lever is now replaced to its original vertical position and the adjusting screw raised.

A machine of this type to take articles up to 4 ins. deep weighs 120 lbs. This new Hardness Testing Machine is manufactured in England by Messrs. Brown, Bayley's Steel Works, Ltd., Sheffield, in whose Research Laboratory it was designed and perfected by the inventors.

Several departments of these works have had these machines in constant use for the past eighteen months for various purposes, in connection particularly with the heat treatment and testing of special alloy steels. The firm would be pleased to receive inquiries from all interested, and to give any further information which might be required.



HARDNESS TESTING MACHINE

Items of Personal Interest

Norman W. Rose has been appointed electrical engineer of the Duluth & Iron Range, succeeding A. M. Frazee.

H. W. Lasser has been appointed superintendent of shops of the Erie at Galion, Ohio, succeeding A. J. Davis.

C. L. Walker has been appointed master car repairer of the Southern Pacific, with headquarters at Los Angeles, Cal.

J. H. Sweeney, storekeeper of the Erie at Meadville, Pa., has been appointed superintendent of stores at Meadville, succeeding H. S. Burr.

T. H. Osborne has been appointed master car repairer of the Los Angeles division of the Southern Pacific, with headquaters at Los Angeles, Cal.

H. S. Burr, superintendent of stores of the Erie at Meadville, Pa., has been appointed general supervisor of stores, with headquarters at New York.

Harry Polland has been appointed general fire inspector on the Southern Pacific, with headquarters at San Francisco, Calif., succeeding Miles Searls, retired.

J. B. Noyes has been appointed storekeeper of the Soo division of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Minneapolis, Minn.

E. H. Hughes has been appointed general storekeeper of the Kansas City Southern, with headquarters at Pittsburgh, Kans., succeeding R. C. Lowry, resigned.

M. A. Hall, master mechanic of the Kansas City Southern, with headquarters at Pittsburg, Kansas, has been appointed superintendent of machinery, with the same headquarters; and C. J. Burkholder, general road foreman of engines has been promoted to master mechanic, succeeding Mr. Hall.

F. V. Green, formerly in the service of the Westinghouse Air Brake Company, and recently associated with the Baldwin Locomotive Works has been appointed export manager in charge of South African territory with offices in the Standard Bank building, Johannesburg, South Africa.

J. H. Douglas, general shop foreman of the Wheeling & Lake Erie at Ironville, Ohio, has been appointed master car builder with headquarters at Brewster, Ohio.

N. M. Barker, master mechanic of the Copper Range has been appointed mechanical superintendent of the American Automatic Connector Company, Cleveland, Ohio.

E. L. Zink, chief clerk in the office of the district storekeeper of the Chicago, Rock Island & Pacific at Silvis, Ill., has been promoted to district storekeeper at Chicago, Ill.

W. H. Eckroate, road foreman of engines on the Wheeling & Lake Erie at Brewster, Ohio, has been appointed master mechanic at Brewster, succeeding J. F. Hill, promoted.

A. S. Sternberg, general foreman of the Belt Railroad of Chicago, has been appointed master car builder, with office at Chicago, the position of general foreman being abolished.

W. G. Cook, manager of the Chicago office of the Garlock Packing Company, Palmyra, N. Y., has been transferred and is now manager of the company's office at Philadelphia, Pa.

N. M. Rice, vice-president of the Pierce Oil Corporation, St. Louis, Mo., has been appointed general purchasing agent of the New York, New Haven & Hartford, succeeding G. G. Yeamans.

Charles W. McGuirk, assistant master mechanic of the Delaware, Lackawanna & Western, has been appointed master mechanic of the Delaware & Hudson, with headquarters at Carbondale, Pa.

J. F. Hill, master mechanic of the Wheeling & Lake Erie at Brewster, Ohio, has been appointed superintendent of motive power and cars, with headquarters at Brewster, succeeding George Dunham, resigned.

E. A. Ernst, chief clerk in the office of the storekeeper of the Chicago, Rock Island & Pacific, at Horton, Kan., has been promoted to district storekeeper at Shawnee, Okla., succeeding E. W. Morris, deceased.

Henry Marsh, formerly passenger car foreman of the Chicago & Northwestern, with headquarters at Chicago, Ill., has been appointed district master car builder of the same road, with headquarters at Winona, Minn.

J. C. Kirk, district storekeeper of the Chicago, Rock Island & Pacific, at Silvis, Ill., has been appointed general storekeeper, with headquarters at Silvis, and W. L. Hunker succeeds Mr. Kirk as district storekeeper.

L. C. Walters, signal and electrical inspector of the Southern, with headquarters at Washington, D. C., has been promoted to signal and electrical engineer of lines West, with headquarters at Cincinnati, Ohio.

H. G. Flanders has been appointed master mechanic of the Atchison, Topeka & Santa Fe, with office at Amarillo, Tex., and W. H. Smith has been appointed roundhouse foreman on the same road at Albuquerque, N. M.

J. A. Deppe, assistant master car builder of the Chicago, Milwaukee & St. Paul, at Milwaukee, Wis., has been appointed supervisor of the freight car department, with headquarters at Milwaukee succeeding C. J. Juneau.

P. V. See, superintendent of equipment of the Hudson & Manhattan tunnels between New York and Jersey City, has been appointed superintendent of equipment of the Northern Ohio Traction & Light Company, Akron, Ohio.

George T. Brown has been appointed master mechanic of the Fernwood & Gulf with headquarters at Fernwood, Miss., succeeding C. N. Spicer, who has resigned to become master mechanic of the Williams Lumber Company, Ponchataula, La.

Elmer R. Larson, supervisor of apprentices of the Delaware, Lackawanna & Western, has been appointed special motive power inspector, and John Murray, assistant superintendent of apprentices has been promoted to supervisor of apprentices, succeeding Mr. Larson.

C. M. Muchnie, vice-president of the American Sales Corporation, New York, has had conferred on him the fourth class of the Imperial Order of Merit, and invested with the insignia of the Imperial Order of the Rising Sun, as an expression of good will towards Mr. Muchnie by the Emperor of Japan for meritorious services.

C. H. Jackman has been appointed sales agent of the Pressed Steel Car Company and Western Steel Car & Foundry Company, western district, with headquarters at Chicago, Ill. Mr. Jackman served as a second lieutenant in the Air Service, and on receiving his discharge from the service was employed by John T. Ryerson & Son as special steel salesman.

A. T. Pfeiffer has been appointed superintendent of fuel and locomotive performance of the New York Central, with headquarters at New York City. J. C. Breenan has been appointed supervisor of fuel and locomotive performance of the first district, with headquarters at Utica, N. Y. C. W. Wheeler, to a similar position in the second district, at Syracuse, N. Y., and Robert McGraw, fuel instructor, also at Syracuse.

R. W. Anderson, assistant superintendent of motive power of the Chicago, Milwaukee & St. Paul, has been promoted to the position of superintendent of motive power with headquarters at Milwaukee, Wis. Mr. Anderson entered railroad service as an apprentice machinist in 1892 in the Des Moines Union railroad, and after many well-earned promotions chiefly in the Chicago & Rock Island, entered the service of the Chicago, Milwaukee & St. Paul as assistant to the head of the mechanical department in 1918.

R. E. Mainprice and T. H. Sanders, M. I. Mech. E., attached to Brown, Bayley's Steel Works, Sheffield, England, arrived in New York last month and are making an extensive tour in the United States for the purpose of observation and study of some of the leading plants engaged in the manufacture of railroad materials. The firm to which these engineering experts are attached is one of the oldest established of the Sheffield works engaged in the heavy steel industry. The chief products of the firm are tires, axles and springs for railway and tram way rolling stock, and special alloy steels for automobile and aeroplane construction. Harry Brearley, the inventor of "Stainless Steel," is the technical director of the firm.

Traveling Engineers Association.

The Traveling Engineers Association, in conjunction with the Railway Equipment Manufacturers Association, will hold their annual convention at Hotel Sherman, Chicago, Ill., September 14 to 17 inclusive. Selections of space in the Exhibit Floors should be made as early as possible, as the indications are this will be the largest convention the Traveling Engineers have ever had, and the exhibits will be proportionally as large. Details may be had on application to Fred W. Venton, secretary, Crane Company, Chicago, Ill.

Railway Section of the American Society of Mechanical Engineers.

E. B. Katte, chairman, O. W. Rink, C. W. Huntington, H. B. Oatley and W. H. Winterrowd have been elected as Executive Committee of the Railroad section of the American Society of Mechanical Engineers. The section will act as an organization of getting together mechanical engineers of railways, designers of railway equipment, and railway supply men, of the discussion of mechanical details. The annual meeting of the Society will be held on December 7-10, 1920.

Inspection of Car Equipment.

An open competitive examination for senior inspectors of car equipment, application closing on August 24. Full particulars in regard to which may be had on application to the Civil Service Commission, Washington, D. C. Those desiring to enter for examination should apply for Form 1312, stating the title of the examination desired. The salaries range from $2,000 to $3,600, with traveling expenses, and in cases of satisfactory service an increased grant of $30 per month.

War Medals Awarded to Pennsylvania Railroad Men.

Commemorative war medals were presented to more than 27,000 Pennsylvania railroad men who served in the United States Army during the war. The presentations were made at meetings held simultaneously on July 10th. The relatives and next of kin of those who died in military or naval service, of which there were 610, received the medals to which the heroic dead were entitled. A letter from Samuel Rea, president of the company, addressed to each recipient accompanied the presentation. The medals, which are in the form of a keystone, are of bronze inscribed with the name of the recipient, and of artistically allegorical design and patriotic inscriptions, and are warmly appreciated by the recipients.

Drilling Hexagonal and Other Holes

The degree of perfection to which the drilling of square holes has attained has induced some of our inventors to proceed further, and, it is claimed that hexagonal and even octagonal holes are being drilled by a Hungarian named Bartholomius.

This new machine is said to be free from the defects of earlier types, and is automatic in its action. It can be attached to any boring machine, lathe, etc., without regard to the type or method of supporting of the particular machine. The device is, in fact, an independent and self-contained tool. The angular holes are drilled very accurately, as the drill is guided over the whole of its length, and the work-piece and the clamping device are in immediate contact with the guides. At the same time that round holes are being drilled, the new type of boring tool automatically drills hexagonal and polygonal holes. To obtain different sized holes it is only necessary to change the drill used.

Domestic Exports From the United States by Countries, During May, 1920

Steam Locomotives

Countries.	Number.	Dollars.
Belgium	62	3,589,700
France	28	840,000
Canada	3	51,292
Mexico	6	60,550
Cuba	5	113,640
Brazil	9	179,810
Chile	2	36,330
Colombia	5	136,479
Ecuador	3	98,025
Peru	3	30,450
China	7	232,764
Chosen	4	118,900
Japan	7	54,420
Philippine Islands	6	5,186
British South Africa	6	358,500
Totals	152	5,906.046

American Locomotives in Africa.

The Lourenco Marques Railway has recently received eight American locomotives, five of the Santa Fe type and three of the Pacific type, and they have proved far superior to any of the foreign engines in use. The Lourenco Marques Railway connects the port of Lourenco Marques with the railway system of South Africa and is the principal outlet for the coal mines of the Transvaal as well as the most convenient route for imports into the region of which Johannesburg is the center.

Rumania Purchasing Locomotives.

The purchase of 50 American locomotives by the Rumanian Government is reported in the Monitor Officiel, and confirmed by the company's representatives, this in active competition with strong British interests. The importance of this first order of locomotives is far greater, therefore, than the measure of the sale itself, for with a reorganized transportation it will be possible to export the very great timber, petroleum and cereal production of Greater Rumania, the exchange will improve, and the population of about 18,000,000 will again offer a possible market for much needed manufactured goods.

The Electrification of a Brazilian Railway.

Following long-continued negotiations, the Paulista Railway in Brazil has placed an order with an American electric company for the electrification of the Jundiahy to Campinas section of its system, a distance of about 44 kilometers. The order comprises eight freight electric locomotives of 91 tons each and four electric passenger locomotives of 110 tons each, as well as a 4,500 kilowatt substation equipment to be installed at Louverra. The overhead line equipment of the "catenary" construction will also be supplied. The substation is to receive power from the Sao Paulo Electric Co. at 88,000 volts alternating current and deliver it to the locomotives at 3,000 volts direct current. According to present plans, the work will be finished and the locomotives in operation by the middle of next year. Possibly the electrification will be later extended to Sao Carlos, making the total distance about 100 miles.

Railroad Electrification in Belgium.

The Minister of Railways in Belgium has decreed general electrification. Belgium is now in a position to electrify to very good advantage, because reconstruction of much mileage is necessary, and new electric equipment can be installed with the aid of the money value of the requisitioned locomotives and other rolling stock, which Germany must make up.

Books, Bulletins, Etc.

STANDARD ELECTRICAL DIRECTORY. By Prof. P. O'Conor Sloane, with additions by Prof. A. E. Watson, of Brown University. Published by the Norman W. Henley Publishing Company, 2 West 45th Street, New York.

This is an entirely new edition of this popular book, revised and enlarged to 767 pages, with minute definitions of about 6,000 distinct words, and illuminated by nearly 500 illustrations. Every term used in electrical science is clearly defined including the very latest nomenclature in use up to the present year. The definitions are such as make the meanings very clear to the non-technical searcher after exact information. The work is indispensable to all who would aspire to a ready knowledge of the correct phraseology necessary in electrical construction and operation. The authors are in the front rank of instructors in their chosen calling, while the enterprising publisher has spared no pains to present the work in the most convenient form. The word or term is printed in black face type which readily catches the eye, while the definitions are in smaller type. Synonyms are also given, and the book in many ways equals, if it does not surpass, the standard dictionaries that are the compilations of the garnered learning of centuries.

Air Brake Association Question and Answer Books.

Book No. 1.—Maintenance of Freight Brakes. A book of instruction, guidance and authority in which special care has been taken to reduce the contents to 150 pages, thereby saving the time in studying the subject. Book No. 2.—Maintenance of Steamdriven Air Compressors. Treats the operation, installation and maintenance of all types of machines. Book No. 3.—400 Questions and Answers on the 6 E T Equipment. The most complete and best book ever issued on the subject. Book No. 4.—Handling trains, passenger and freight, will be ready in the near future. Orders should be addressed to F. M. Nellis, Secretary, Air Brake Association, 165 Broadway, New York.

Locomotive Feed Water Heater.

Bulletin No. 6, has just been issued by the Locomotive Feed Water Heater Company. It is particularly interesting on account of a chart graphically showing the exact amount of saving per locomotive per month for any combination of fuel costs, and amounts of consumption, and also includes the gross ton miles. The data is collected from locomotive performance in actual service, and it may be justly claimed as the first reliably convincing proofs that the heating of feed water can be as successfully conducted with as great a degree of economy as it is in marine or stationary engine service.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXIII 114 Liberty Street, New York, September, 1920 No. 9

Norfolk & Western Railroad Shop Kinks

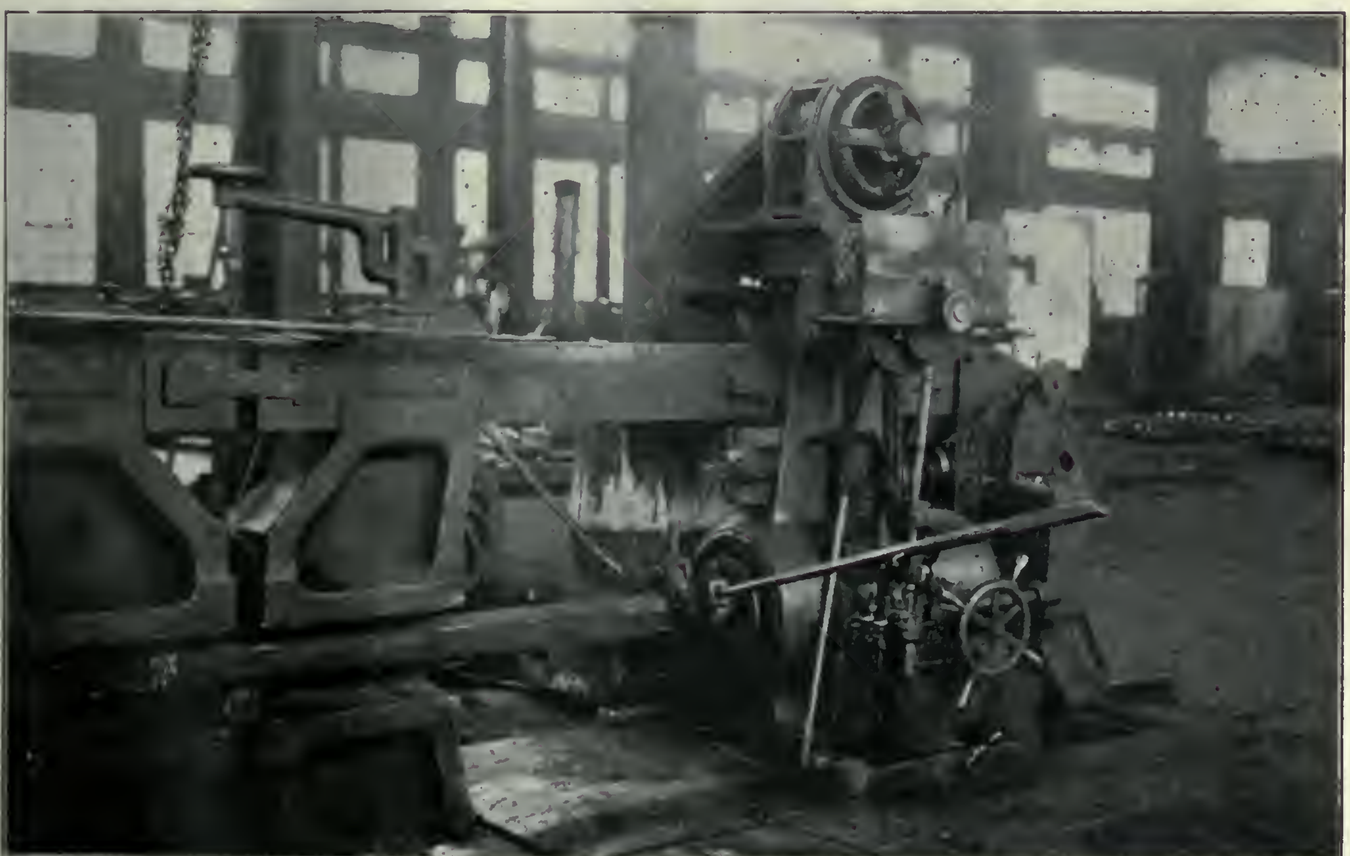
Putting Bushings in Hydraulic Presses

Usually when a hydraulic press fails it is in the midst of a job and everything has to stop until repairs are made. The most serious of these breakdowns is when the bushing in the cylinder fails. When this occurs, the user is ordinarily obliged to dismantle the machine and send the cylinder to the maker for repairs, and the latter usually furnishes the information that no other course is possible.

Such was the condition of affairs in the Norfolk & Western shops something more than a year and a half ago. The quickest estimate that they could get for the replacing of a failed copper bushing was from five to six weeks, with no certainty that this would not be greatly exceeded. Under such circumstances an attempt was made to replace the bushing on the premises.

To do this a set of expanding rollers was fitted to an ordinary cylinder boring machine and the work started at the front end and carried back to the bottom, and thence to the front again. When this round trip had been made it was found that the bushing had been successively stripped from its fastenings and stretched so that it extended for two inches or more beyond the face of the cylinder. In short, the method was a failure, and is quoted here merely that others may not try it and get the same results.

This having been done and progressive rolling having been demonstrated to be not the thing a set of rolls having a length equal to the bushing to be rolled was made. These were arranged to work in the same way as a Dudgeon expanding roller, and the pin was pushed in by the plunger of the second cylinder as shown in the illustration. In operation the rolls



METHOD OF ROLLING COPPER BUSHING IN HYDRAULIC PRESS. NORFOLK & WESTERN RAILROAD are put in the bushing and the flange on the frame of the rolls sets up against the end of the cylinder. The rolls are turned by two bars working, a ratchet as shown, and this can be done by four men.

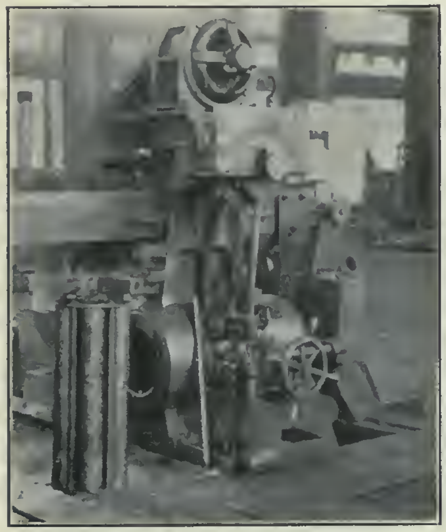
The time required to remove an old copper bushing and put in a new one and have the machine in working order again is about five hours. The thickness of the bushings thus far inserted and rolled out is about ⅛ in.

As for the durability and effectiveness of the work; one of the bushings has now been in service for about twenty months with no leakage and no demands for attention.

The bushings used are made of sheet copper cut, rolled into a cylinder and soldered with an outside diameter that permits them to slip easily into the cylinder.

PERFORATING PLATES

Considerable difficulty having been experienced in obtaining perforated plates



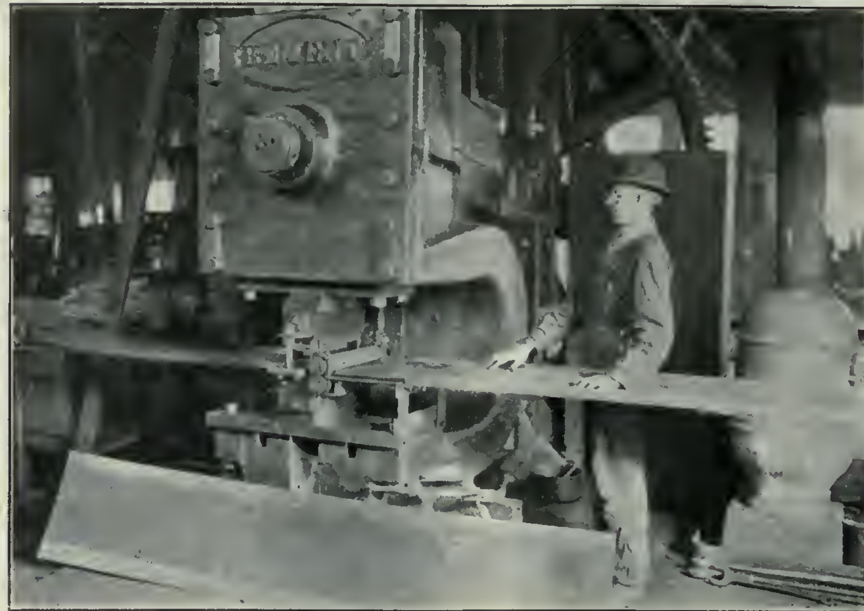
ROLLER FOR COPPER BUSHING OF HYDRAULIC PRESS

for making driving box lubricators, a punch has been designed to be used on a heavy punching machine to do the work. The plates are of about 14-gauge steel and the perforations are 3/16 in. in diameter and ⅜ in. from center to center. The plates punched are about 15 in. wide.

A set of gang punches are attached to the head. This gang consists of four rows having 26 punches in each row, so that 104 holes are punched at each stroke of the head. The sheet is automatically fed under he punch by a knurled roller pressed down on the sheet and turned so that the sheet is moved a distance equal to four times the pitch of the holes at each upward stroke of the punch head. This is a simple pawl and ratchet feed that does not start to act until the punches are clear of the sheet. The work done is even and without a flaw.

PRONG BRAKE FOR TESTING AIR DRILLS

It having been found that repaired air drills do not always develop the power that they did when new, a prong brake has been made in which to test them. The drills are attached to the brake when they are new and a run made to determine the

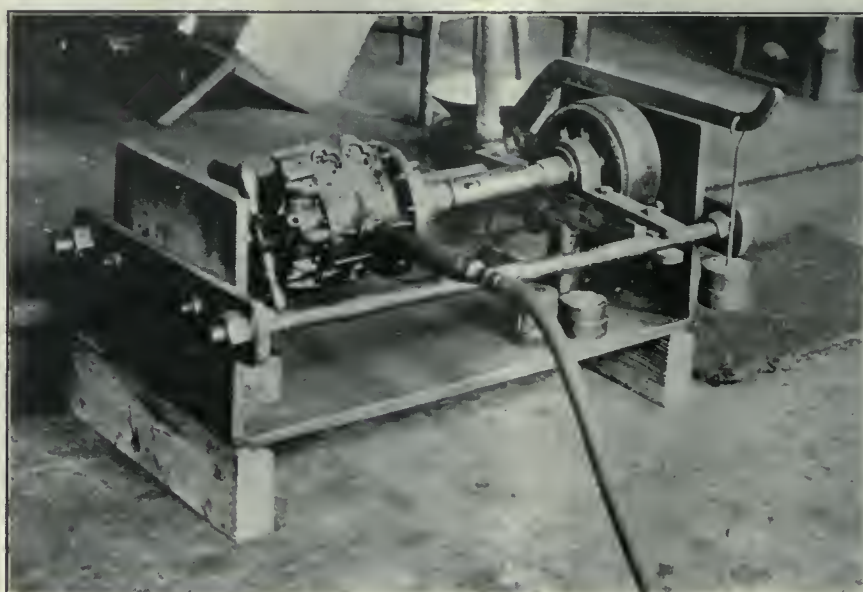


GANG PUNCH FOR MAKING PERFORATED METAL SHEETS

power that they can develop when new and running at speed. Then, after they are repaired, they are tested again, and if they fail to come up to the power development, when new, they are taken apart and overhauled until they are up to the standard. This insures the issuing of tools that are capable of doing the work for which they are intended.

CRANK PIN KEYSEATING MACHINE

The Norfolk & Western shops at Roanoke are making liberal use of air drills for various classes of work, a little out of the range of the work for which they were designed. One such use is that of driving a milling cutter used in cutting keyways in crankpins for fastening the return or eccentric crank. The illustration shows the device attached to a crankpin and ready for operation. The miller (1) can be seen projecting below its casing. The upper end of the miller spindle (2) is in the form of a taper drill shank on which the socket of the air drill sets



PRONG BRAKE FOR TESTING AIR MOTORS

and fits. When running the drill is steadied by the two handles (3) in the usual way. The miller is fed into the work by a thread terminating in the head (4) which is turned by a wrench. Various sizes of sleeves (5) are provided to fit over the different crank pins. The work done is smooth and rapidly executed and saves the trouble and expense of removing the crankpin when the keyway is worn, or the slow process of cutting the keyway by hand.

The Situation of Railway Electrification

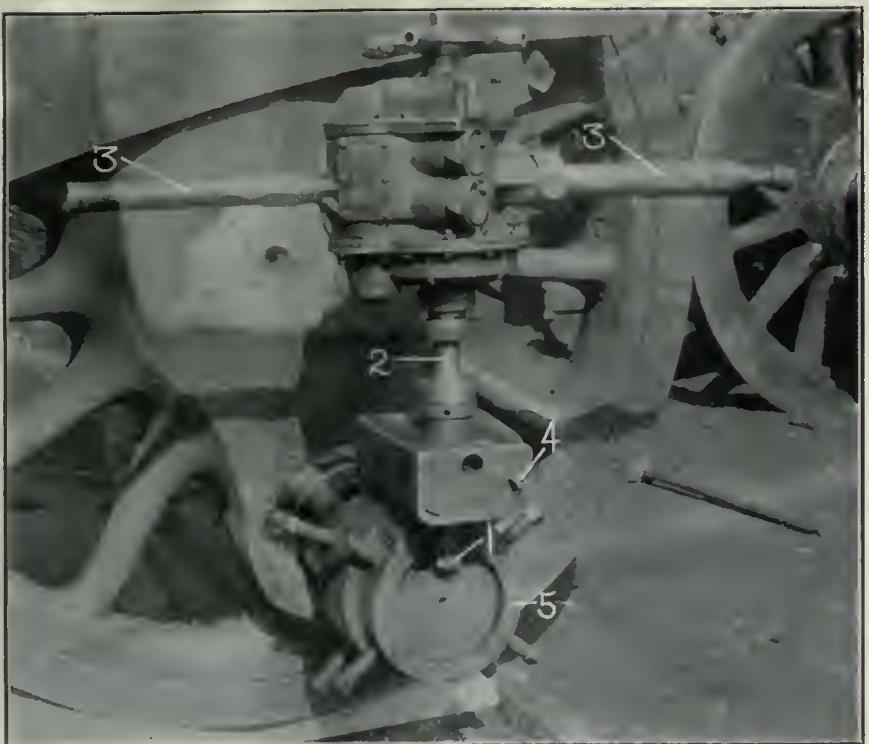
M. Parodi, the chief electrician of the Orleans Railway, has published a paper in *Le Revue Generale des Chemins de Fer* in which he sums up the general situation in the principal countries of the world in the matter of the electrification of railways, of which the following is an abstract:

United States: The United States produces about 500,000,000 tons of coal per annum and consumes about 115,000,000 tons on its railways, and does not consider the electrification of its railways a thing that will be of general extent, in spite of the great advances that have been made in this direction, because the cost of fuel has hardly yet reached that prevailing in Europe before the war. It is still too low for a decrease of 35 to 50 per cent in consumption which electrification would bring about to cover the cost of installation.

Even in those states where coal is scarce and oil expensive, or even where there are important hydraulic developments, electrification presents only inappreciable advantages. The electrification of the Chicago, Milwaukee & St. Paul is given as the most important in the world.

Europe: In Europe the coal crisis has brought a large number of electrification projects to the front, whose completion ought to be vigorously pushed, especially where the coal situation is particularly acute, as in Switzerland, Italy and France.

Switzerland: The actual coal consumption on locomotives is about 3,500,000 tons, all of which has to be imported, but the country is possessed of hydraulic riches more than sufficient to electrify all of its railroads. For a single system such as the federal operating about 2,700 miles, an average load of about 200,000 horsepower would be required capable of carrying a peak load of 600,000 horsepower.



PORTABLE CRANKPIN MILLER

The matter was taken up in 1913, but was dropped during the war; but in 1918 a program for a general electrification was presented to the Government. The system proposed is the single phase of 15 cycles and 15,000 volts, although the three-phase has been considered.

In the program proposed, the lines are divided into three very unequal groups, the first of which, with 675 miles, would require an average hydraulic development of 76,000 horsepower, and would effect a saving of nearly 2,000,000 tons of coal.

The second group contains about 360 miles, and includes lines of small traffic, but whose electrification would be very interesting because of their geographical location.

The third groups takes in the rest of the system.

This vast program has every promise of being executed. The federal railroads are ordering no more steam locomotives, but their whole financial effort is being concentrated on the electrification. The St. Gothard line will be put into service without delay.

Italy: The Italians have been tenaciously devoting their attention to the electrification of their railroads for twenty years, and the installations in service compare in magnitude with those of America. This action is readily explained by Italy's poverty in coal and richness in hydraulic power. Italy is obliged to import all of its coal or more than 11,000,000 tons, while it has more than 5,000,000 horsepower that is only partially utilized.

The technical success of electric traction and the successful operation under the three-phase system, have justified its establishment. In the future, the same policy ought to be followed, with perhaps an accentuation of its industrial character.

From the recent discussions at the Congress of Trente, it does not appear that the engineers of the State Railways are disposed to abandon the three-phase system, in spite of outside adverse criticism, but the question will be examined by a committee of fifteen members appointed by the Minister of Public Works.

France: In France, while the situation is not as critical from the fuel standpoint as it is in the neighboring nations, yet it is serious and it were well to develop the hydraulic power of the country, amounting to about 8,000,000 horsepower, as soon as possible.

In 1913 the coal consumption in France amounted to 60,000,000 tons, of which not more than two-thirds was the product of French mines. Of this total about 7,000,000 tons were consumed by the railways. It is estimated that in a dozen years this deficit of 20,000,000 tons will be increased to 37,000,000 or 40,000,000 tons if the consumption of Alsace-Lorraine as well as the normal increase in demand is taken into account. The railway consumption will also be raised from 7,000,000 to 10,000,000 or 12,000,000 tons.

Electrification will probably enable a part of this increase to be met. The program adopted, which includes about 4,950 miles of line, including the 90 miles or thereabouts of the Midi Company, already equipped, will permit the actual coal consumption to be reduced about 2,000,000 tons.

In this program the Midi proposes to electrify 1,800 miles, or its whole system with the exception of lines at Bordeaux, Cette and the branches.

The Orleans will electrify about 1,800 miles as well as all the branches on the sections affected.

The Paris-Lyons and Mediterranean will electrify about 1,325 miles, in which will be included the heavy traffic line between Lyons and Marseilles.

Sweden: The question has been under discussion since 1902 and some experiments were made in 1905 to 1907 on a line running out of Stockholm with a single-phase system working at 20,000 volts, and the Government has decided to adopt this system for future electrifications. The mining road from Kiruna to Riksgransen, having a length of 72 miles, has been electrified and it is the intention to extend it over the greater part if not the whole of the Swedish system, in order to utilize the cheap hydraulic power abounding in the region.

The program laid down by the General Railroad Committee in 1919 provides for the construction of eight central hydraulic plants, capable of furnishing 700,000,000 kilowatt hours, of which 400,000,000 will be used by the State Railways.

Germany: Although producing 280,000,000 tons of coal per year, Germany had not waited for the war to force a study of this question upon her. A dozen years ago she had elaborated a vast program of electrification in all its amplitude. The electric energy necessary for the hauling of the trains was to have been furnished by plants burning the turf and lignites of northern Germany, where they lie, and the light coals of southern Germany. The amount of power available was placed at 1,500,000 horsepower. The line from Dessau to Bitterfeld, which was built in 1909, is only the first section of the main line from Magdeburg to Leipzig (67 miles) to be electrified and is fed by current generated at Muldenstein near Bitterfeld, which is situated in the midst of rich lignite deposits.

The Petroleum Situation in the Caucasus.

The scarcity of the petroleum oils and the rising prices of the same in this country give a special interest to a report that has been made on the petroleum situation in the Caucasus by M. Aldebert as published in *Le Geine Civil.*

Communication with the oil regions of the Caucasus, which was becoming more and more difficult since 1914, was cut off entirely in 1917 because of Bolshevism and the Turco-German occupation. At the present time we are still very poorly informed on the subject. Widely different and contradictory reports are in circulation, and the report of M. Aldebert sets out to classify the situation as it existed on January 1, 1920.

Almost the whole of the Russian oil production comes from the Caucasus. In 1916 this amounted to about one-sixth of the total production of the world, and ranked Russia as next to the United States as a producer of mineral oil.

Although the Caucasus forms a continuous oil-bearing basin, for indications are found upon both the northern and southern slopes of the mountains, M. Adelbert divides the territory into three sections where the principal developments are concentrated.

1. The Maikopp section, which yields about 1.2 per cent. of the Russian output.

2. The Grosny section, which yields 17 per cent.

3. The Baku section, yielding 78 per cent.

In the Maikopp section, which is divided into three groups, there are 138 wells, of which only 38 are worked. These have a daily yield of about 67,000 gallons. The principal group at Maikopp is connected with the refineries at Ekaterinodar by an 8-inch pipe line about 87 miles long. The other two groups are connected by pipe lines to the tanks on the Ekaterinodar and Nova-Rossisk railway. The production of the Maikopp section rose from 503,000 gallons in 1908 to 47,140,000 gallons in 1912, but fell to 10,309,000 gallons in 1916, while in 1919 the output had again risen to 15,400,000 gallons.

These operations have suffered very little from the war, being situated in the center of the provinces of Couban and Tereck, where the population is Cossack and, from the very outset of the revolution, have resisted the Bolshevik movement and have made up the nucleus of Denikine's army.

At Grosny the section is divided into two parts, that of the Old and New Rayon, located at a distance of about 9 and 3 miles, respectively, from the city. The operations at Old Rayon have not been destroyed, either by the revolution or the uprising of the populace, but at New Rayon the operations have been almost totally destroyed.

In November, 1917, seven flowing wells were fired and burned until February, 1919. Some of these wells had a yield of more than 283,000 gallons a day. An immense layer of lava produced by the burning oil covers the slopes of the hills to a depth of more than a foot. This lava consists of a petroleum coke and is actually used as a fuel under boilers. The wells which were not burned were destroyed with the axe and dynamite.

At New Rayon, out of 122 wells which existed before the revolution, only 5 are now being worked; 7 are being repaired, while the others are idle or have been abandoned.

The operations of the Grosny basin were begun in 1896, and grew continuously, except for a slight fluctuation during the first revolution of 1906, and reached a total yield, in 1917, of 550,300,000 gallons; but it would have reached 786,000,000 gallons had transportation facilities been sufficient.

In addition to tank cars there were 8-inch pipe lines leading from the district to the Caspian and Black Seas which, before the war, had a daily capacity of 10,310,000 gallons, while to-day, after repairing the pipe line destroyed in 1917 and the two pumping stations out of four, the capacity is only 471,000 gallons a day.

At Baku the production of the Akcheron peninsula, which was 258,000,000 gallons in 1882, steadily increased until it reached its maximum of 3,457,000,000 gallons in 1901. The revolution of 1905 cut the production of this section down to 2,106,000,000 gallons, but as matters became settled it rose to 2,467,000,000 gallons in 1916, although the scarcity of repair parts, machinery and material began to make itself felt in consequence of the war and the closing of the Dardanelles. The year 1918 brought in anarchy, and industry was completely paralyzed.

The year 1918, with a production of 630,000,000 gallons, saw the nationalization of the petroleum industry, followed by a Turkish occupation after several days of bombardment with its horrors and massacres. The economic disorganization is complete; there are now neither new operations nor exportations, and output is reduced to a minimum, so that we have to go back to 1889 to parallel it.

At the end of 1918 English and Russian troops occupied Baku anew. It had suffered from bombardment, but the operations were intact.

In 1919 a Tartar government was established, which later became the Republic of Azerbeidjan and was actually recognized by France. When order was established in August, 1919, the English evacuated Baku and, contrary to the forecasts, there were no massacres and no disorder.

But oil production was reduced to a minimum because there were almost no exportations, Astrakan being in the hands of the Bolsheviki, and Astrakan, before the war, handled about 75 per cent. of the Baku exportations.

In order to span this crisis the government advanced money to the operators in order to enable them to carry forward new operations, but as the tanks are full the situation is a difficult one. The exportation of oil from Baku is greatly reduced because of the lack of railroad transportation and the difficulty of passing through Georgia. The estimated production for 1919 is 1,257,000,000 gallons.

The average production of wells, which was 4,400 gallons per 24 hours in 1904, was 1,445 gallons in 1917, 1,165 gallons in 1918 and 1,730 gallons in 1919. Since the war the drilling of new wells has shown a constant decrease, falling from an average of 37,720 feet per month in 1913 to 13,120 feet at the end of 1917 and 1,400 feet at the end of 1918. For 1919 the average is still lower.

Meanwhile living expenses are very high, materials scarce and high priced. Though the government is making every effort to relieve the situation, which is one that affects the industries of the whole world and especially those of the United States by the unprecedented demand the low output of the Russian oilfields causes to be placed upon those of the United States.

Cement for Pipe Joints.

Heavy cylinder oil mixed with the graphite to form a thick paste.

Switching Locomotives for the Chicago, West Pullman & Southern Railroad

Equipped with the Young Valve Gear

The Baldwin Locomotive Works have recently delivered a six-coupled switching locomotive to the Chicago, West Pullman & Southern Railroad, a photograph of which appears on this page. With the exception of a locomotive built some years ago for the Bessemer & Lake Erie Railroad, which weighed 183,750 pounds, this is the heaviest locomotive of its type thus far constructed by the builders. It weighs 178,200 pounds, or approximately 60,000 pounds per axle, and develops a tractive force of 44,400 pounds. The ratio of adhesion is thus practically 4, so that the weight on driving wheels is fully utilized for tractive purposes.

The cylinders are 23 inches in diameter with a 28-inch stroke and piston valves 14 inches in diameter are used. The valves have a steam lap of 1 5/16 inches and are set with a 3/16 inch lead, the travel being 8¼ inches. The maximum cut-off is 88½ per cent. The Young valve gear is applied and is controlled by a Ragonnet power reverse which, owing to the limited amount of space, has been placed at the side of the firebox on a level with the mud ring. The reverse shaft is placed between the second and third pairs of drivers; and the links, which are driven directly from the crosshead pins, are supported on longitudinal bearers outside of the second pair of drivers.

The main rods are connected to the rear driving wheels. The main stubs are of the strap type, fitted with adjustable cast steel wedges, and so designed that the brasses can be removed without taking down the straps. The piston heads are of steel, and are made with a dished section to reduce weight.

The boiler is of the straight top type with a wide firebox and the firebox throat is immediately above the rear pair of driving wheels. The boiler contains a superheater and is equipped with a power operated fire-door.

The tender wheels are of rolled steel and were furnished by the Standard Steel Works Company.

The principal dimensions are as follows:

Gauge, 4 ft. 8½ ins.; cylinders, 23 ins. x 28 ins.; valves, piston, 14 ins. diam.

Boiler.—Type, straight top, diameter, 78 ins.; thickness of barrel sheets 13/16 in.; working pressure, 180 lbs.; fuel, soft coal.

Firebox.—Material, steel; staying, radial; length, 90 ins.; width, 66 ins.; depth, front, 74½ ins.; depth, back, 65½ ins.; thickness of sheets, sides, ⅜ in.; thickness of sheets, back, 5/16 in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, ½ in.

Water Space.—Front, 5 ins.; sides, 4½ ins.; back, 4½ ins.

Tubes.—Diameter, 5½ ins.; material steel; thickness, No. 9 W. G.; number, 36; length, 12 ft. 6 ins.

Tubes.—Diameter, 2 ins.; material, iron; thickness, No. 12 W. G.; number, 228; length, 12 ft. 6 ins.

Heating Surface.—Firebox, 158 sq. ft.; tubes, 2,126 sq. ft.; total, 2,285 sq. ft.; superheater, 552 sq. ft.; grate area, 41.2 sq. ft.

Driving wheels, diameter, outside, 51 ins.; diameter, center, 44 ins.; journals, 10 ins. x 12 ins.

Wheel base.—Driving, 11 ft. 0 ins.; rigid, 11 ft. 0 ins.; total engine, 11 ft. 0 ins.; total engine and tender, 46 ft. 11½ ins.

Weight.—On driving wheels, 178,200 lbs.; total engine, 178,200 lbs.; total engine and tender, 338,700 lbs.

Tender.—Wheels,, number, 8; wheels, diameter, 33 ins.; journals, 5½ ins. x 10 ins.; tank capacity, 8,000 U. S. gals.; fuel capacity, 14 tons; tractive force, 44,400 lbs.; service, switching.

SIX-COUPLED SWITCHING LOCOMOTIVE FOR THE CHICAGO, WEST PULLMAN & SOUTHERN RAILROAD. BALDWIN LOCOMOTIVE WORKS, BUILDERS

A North and South American Railway.

The often discussed proposal for a north and south American railway extending from Hudson Bay to Patagonia is again being revived. This line would be approximately 10,000 miles long, and it is estimated the trip could be made in 10 or 12 days. The projected railway, while it has been advocated to some extent for the past 50 years, obtained the official endorsement of the International American Conference in 1902, and has again been considered by the Pan-American financial conference held in Washington. For quite a number of years most of the South American republics have been linked up by railways, and the Peruvian Government is building additional lines so that a north and south railway on the southern half of the continent is within measurable realization. The same may be said of the railway situation in Canada, the United States and Mexico, where something like a through route will be available on the completion of the Hudson Bay Railway by the Dominion Government. The greatest difficulty to be overcome is in Central America, where the population apparently is not deeply interested and the geological conditions to be met with are discouraging.

Actuating Mechanism of the Steam Locomotive

Details of the Young Valve Gear

Young Valve Gear

We recently took occasion to make some extracts from an excellent paper submitted by F. Williams, Mechanical Designer, Canadian National Railways, Moncton, N. B., on the subject of locomotive valve motions, which attracted wide attention. The subject is always of interest among railway mechanical men, and our only regret was that we had not space to make further extracts embodying some of the salient features of the discussion that the paper called forth.

Among these, while all of the comments were of real value, coming as they did from men of wide experience, the remarks submitted by O. W. Young, the inventor of the Young Valve Gear, were of special interest, coming as they did from an accomplished engineer who has devoted much time and attention to the subject of valve gears as applied to locomotives, and whose work as an inventor is being appreciated more and more as time goes on.

In the course of his remarks Mr. Young stated that "the dynamic operation of a locomotive steam engine is accomplished by four essential acts—steam admission, expansion, exhaust and compression.

ADMSSION

Admission is the act of directing steam pressure against a piston. It is the motive agent employed for revolving the wheels. The duration of the admission period must be subject to control by the locomotive engineer. At his option it should be possible to admit steam to the cylinders during nearly the entire piston stroke, in order to insure positive starting reliability and maximum power for initial train movement. The maximum cut-off must therefore be late.

After starting a train it must then be possible to manually shorten cut-offs (the admission period), because less power is required to keep a train moving than is necessary to start and accelerate it, and because also, small volumes of steam must be used on account of difficulty of rapid exhaust after speeds become considerable, and further because it is impracticable to design locomotives with proper ratios between boiler capacity and cylinder volume to permit the use of full cylinder capacity only at low speeds. In addition, late cut-offs are uneconomical, since they preclude effective expansion.

The range of duty required by a locomotive in starting, accelerating, attaining and maintaining high speed, is so great that it necessitates a wide range of cut-offs subject to control by an engine driver.

The admission period must begin as early as the beginning of a piston stroke. It may, and usually does begin before the completion of the piston's return stroke and that portion of its period is called pre-admission. Steam is then admitted against a piston, tending to check movement and cushion its momentum. The pre-admission period should not commence before the crank pin is practically on a dead centre when working in late cut-offs and consequently slow speed. But it may, and it is desirable that it should begin considerably earlier when in early cut-offs (high speed position), because piston velocity is then greater, and greater cushioning power needed to absorb the shock of checking and reversing the direction of piston movement.

It is desirable that during the admission period steam flow should be unobstructed in order that there may be but little drop in pressure against a piston up to the point of cut-off.

Any valve actuating mechanism tending to increase the widths of steam port openings is therefore for that purpose basicly sound.

EXPANSION

Expansion is the act of prolonging steam pressure against a piston after admission ceases. A mass of steam then in a cylinder cut off from further replenishment from a boiler, continues to expand and propel a piston with decreasing pressure until it is permitted to escape to the atmosphere. All piston movement during this process causes rotative impulse to the driving wheels without further drain on a boiler and is in the direction of fuel economy. The expansion period should therefore embrace the greatest practicable portion of piston movement. In all successful valve gears the relative duration of the expansion period increases with shortened cut-offs. Expansion should be continued as late in the stroke as possible, and any valve gear that permits this, is in this respect desirable, provided it does not introduce objectionable features affecting other events in the cycle.

EXHAUST

Exhaust is the act of relieving a cylinder of pressure. Its period may be divided into two stages. First, after expansion has been carried as late in the stroke as practicable, all steam tending to propel a piston should be permitted to escape to the atmosphere. Unobstructed means should be provided for escape to the lowest obtainable pressure by the time a piston has reached the end of a stroke, so as to insure the least possible initial back pressure during the return stroke. This is particularly desirable at high speed, because it is not only then more difficult to accomplish, but the piston speed is then so great that it precludes material lowering of back pressure ahead of the advancing piston during this, the second exhaust stage. A valve gear therefore that causes rapid valve opening during the first exhaust stage, and maintains liberal opening during the second stage, not only increases effective cylinder pressure, but the increased power is produced economically because of low negative pressure.

COMPRESSION

Compression is the art of building up pressure to cushion a piston at the end of the stroke. Compression together with pre-admission serve to fill the clearance space between the piston when at either extreme position nearest its cylinder head and valve. These together insure high initial pressure. All steam pressure remaining in a cylinder at the beginning of compression, together with 15 lbs. atmospheric pressure, are concentrated into smaller space and should then approximate steam chest pressure. Compression and pre-admission blend into a common pressure. Compression costs only to the extent that it retards wheel revolution. Pre-admission costs in addition the amount of steam it draws from a boiler. Therefore, the terminal pressure should be largely caused by compression. That is, terminal compression should be so high that it will require but little if any additional pressure from pre-admission to build up a pressure equal to that in a steam chest. Compression should and does in all successful valve gears begin earlier at high speed (in short cut offs) than at low speeds. But at low speed terminal compression is lower and the influence of pre-admission more pronounced and expensive. At high speed it is difficult to avoid excessive compression, and any valve gear tending to lower initial compression logically accomplishes some economy.

Conceding that "valve motion *has* today reached a point where it cannot be greatly improved upon" does it follow that we cannot consider the constantly increasing cylinder sizes which demand the rapid handling of greater volumes of steam and, consequently, more liberal means of handling this volume?

When 20 in. cylinders were, the maximum in service the valve travel was 6 in., which was thought sufficient. An analysis of numerous tests with which this speaker is familiar showed excellent steam distribution in 20 in. cylinders with 6 in. travel and 12 in. piston valves. That combination is therefore used as a basis for the arguments herewith presented.

The first duty required of a locomotive in train operation is the start. To insure this it is capable of demonstration by an analysis of main rod angles, and it is further proven by actual experience, that the maximum cut-off must be approximately 88 per cent of the piston stroke. If of less than that percentage, a locomotive will frequently fail to start even though coupled to a comparatively light train, without first slackening back and not only reducing the initial load resistance, but also changing the crank and rod angles to more favorable leverages.

In order to provide for 88 per cent maximum cut-off, the sum of lap and lead must not exceed 19 per cent of valve travel. A valve setting in the following tables is therefore so arranged:

Cylinder Diameter.	Sq. Inch Piston Area.	Valve Travel.	Lap and Lead 19% of Travel.	Lap.	Lead.	Valve Diameter.
Ins.		Ins.	Ins.	Ins.	Ins.	Ins.
20	314	6	1 9/64	57/64	1/4	12
25	491	7	1 21/64	15/64	1/4	17
30	707	7	1 21/64	15/64	1/4	24

Port Length.	Port Width 25% C. O.	Port Area 25% C. O.	Maximum Cut-off.
28.7 ins	9/32 in.	8 ins.	88%
42 ins.	19/64 in.	12.3 ins.	88%
60 ins.	19/64 in.	17.7 ins.	88%

It will be noted in the table that for 20 in. cylinders the piston area is 314 square inches, the valve diameter 12 in. with 28.7 in. port length exclusive of bridges, valve travel 6 in., lap 57/64 in., lead ¼ in., maximum port opening in 25 per cent cut-off, 9/32 in., which causes 8 square inches steam port area. This is equal to 1/40 of the piston area.

Assuming that a ratio of piston area to port area in 25 per cent cut-off of 40 to 1 is necessary for rapid steam flow into a cylinder during admission, and assuming that the valve travel for larger cylinders is increased to 7 in., with valve lap of 1 5/64 in,, and lead ¼ in., then for 25 in. cylinders with 491 square inches of piston area the port area should be 12.3 square inches. This would require a valve 17 in. in diameter, with ports 42 in. long exclusive of bridges. Thirty-inch cylinders with 707 square inches of piston area 7 in. valve travel, 17.7 in port area require valves 24 in. in diameter, with ports 60 in. long.

Twenty-five per cent is considered in the foregoing, because that is the desired running cut-off, as all valve events then combine to produce the best economy and efficiency. Valve travel of only 7 in. is mentioned, for the reason that with the Walschaerts gear greater travel involves such acute angles in the movement of certain members of the gear that designing engineers have been reluctant to introduce them.

It is clearly shown that so far as the admission period is concerned, cylinders of 25 to 30 in. diameters require valves of 17 to 24 in. diameter to produce as free steam flow as 20 in. cylinders receive with 12 in. valves.

When it is considered that 16 in. valves are the maximum now in service and that there are very few in service in passenger locomotives of over 14 in diameter, it is very evident that the larger cylinders are handicapped by insufficient port areas.

Cylinder Diameter	Sq. Inch Piston Area.	Valve Travel.	Lap and Lead 19% of Travel.	Lap.	Lead.	Valve Diameter.
Ins.		Ins.	Ins.	Ins.	Ins.	Ins.
25	491	9	1 23/32	1 11/32	3/8	11
30	707	9	1 23/32	1 11/32	3/8	16

Port Length.	Port Width 25% C. O.	Port Area 25% C. O.	Maximum Cut-off.
26 ins.	15/32ins.	12.3 ins.	88%
38 ins.	15/32 ins.	17.7 ins.	88%

Table No. 2 shows that with 9 in. travel 11 in. valves may be used for 25 in. cylinders and 16 in. valves for 30 in. cylinders and still retain a 40 to 1 ratio between piston and steam port areas in 25 per cent cut-offs.

A valve gear arranged for 9 in. travel thus not only permits the use of smaller valves, but it may use valves now standard to large locomotives and greatly improve ratios between port and piston areas and thus insure very high initial pressure against the piston up to the point of cut-off, even at high speeds. As a result, it consequently has capacity to either haul heavier trains, or attain and maintain unusual speed, or both so far as the influence of admission extends.

If the sum of lap and lead is 19 per cent of travel and the ratio between lap and lead the same, one gear with 7 in. travel and the other with 9 in. the duration in expansion periods in various cut-offs is alike, providing the exhaust setting is line and line in both cases but more exhaust clearance may be used with increased travel without relatively shortening expansion.

Due to the fact that steam is cut off at higher pressure because of more adequate port openings the piston pressure is higher during expansion period, particularly at high speed, and increasingly so for increased cylinder diameters than is possible with gears causing less valve travel.

It is evident, therefore, that increased power induced by improved admission caused by the gear with greater travel continues during the expansion period.

Initial pressure is applied to a piston at the beginning of its stroke. At that position all back pressure should have disappeared. The valve should have then caused the widest possible opening to the atmosphere. As the valve is displaced from its central position, the amount of lap and lead for the above piston position, and assuming that it is designed for line and line exhaust, the width then of exhaust opening is lap plus lead. Reference to the foregoing table shows that this is more than ⅜ of an inch greater in one case than the other, and this additional ⅜ of an inch in width of exhaust port opening obtains throughout nearly the entire exhaust period and in all cut-offs. Due to its greater valve travel the exhaust port opens more rapidly in one case and it accomplishes decidedly wider openings during both exhaust stages.

Increased capacity is thus provided for rapidly expelling large volumes of steam. Rapid valve opening during the first exhaust stage vacates the cylinder to an unusually low initial back pressure and unusual width of exhaust opening during the return piston stroke further permits reduction in back pressure. This results in economically increasing effective pressure and further augments the cylinder power created by improved admission.

It logically follows then that with lowered back pressure, the pressure initially subject to compression is lower, and therefore lower terminal compression results, a further augmentation of cylinder power.

If the premise is sound on which this analysis is based it is confidently submitted that greatly increased valve travel with proportionately increased lap economically increases cylinder power.

1. By adequate steam port openings high pressure is maintained up to the point of cut-off.

2. On account of high cut-off pressure, expansive pressure is high.

3. Due to rapid and liberal exhaust port openings, exhaust is early and completely accomplished and low back pressure obtained.

4. Because of low initial compression, terminal compression is low.

The improvement accomplished in those four acts cause high positive pressure, low negative pressure, increased mean effective pressure and result in greater draw bar pull. The practical operating benefits are positive reliability in starting; rapid acceleration; great hauling power, particularly at high speeds, capacity for unusually high speed and economical use of coal and water.

It is in the hardest service that these benefits are most pronounced and upon the largest locomotives that they attain their maximum value for these benefits become relatively greater with increasing cylinder diameters."

THE YOUNG LOCOMOTIVE VALVE GEAR

The foregoing embodies the greater portion of Mr. Young's comments arising cut of the subject under discussion and, by way of appendix it will be of interest at this time to glance briefly at the leading features of the device which bears his name, and which has already met with a considerable degree of popular favor in the United States and Canada. Not only so, but now that the railroads will shortly be in a better position to give attention to the claims of improvements than they have been since the appliance referred to came under observation, it is not unlikely that the merits of many important improvements in railroad appliances may become better known.

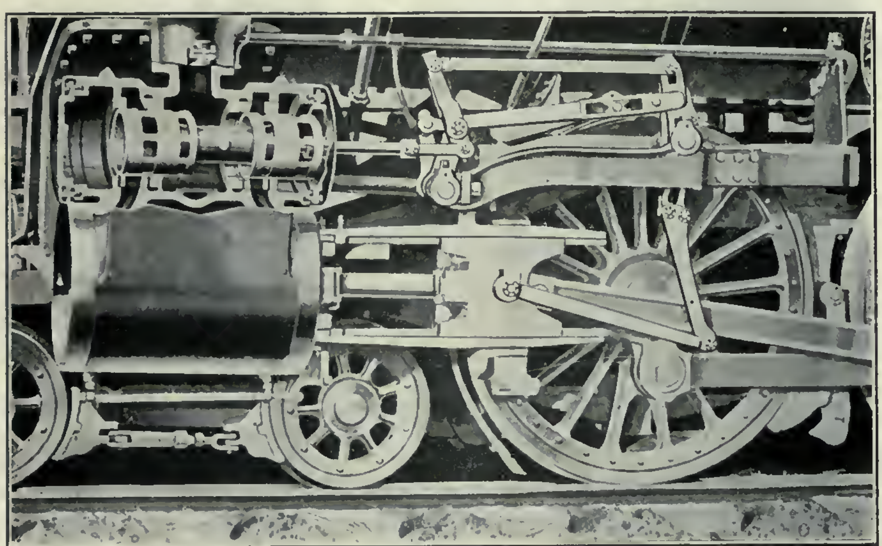


FIG. 1. VIEW OF VALVE GEAR APPLIED TO A LOCOMOTIVE WITH VALVE EXPOSED

FIG. I, is a view of the valve gear as applied to a locomotive. The valve chamber and valve are partly exposed. It will be observed that the valve chamber is slightly longer than the cylinder to afford room for the longer valve travel and wide exhaust cavities. Owing to the unusually free pre-release caused by the wider exhaust openings, together with the open valve construction, it is possible to reduce exhaust clearance, and in some cases valves are said to be running in high speed passenger work with line and line exhaust. This of itself is a logical reason for economies claimed in coal and water consumption.

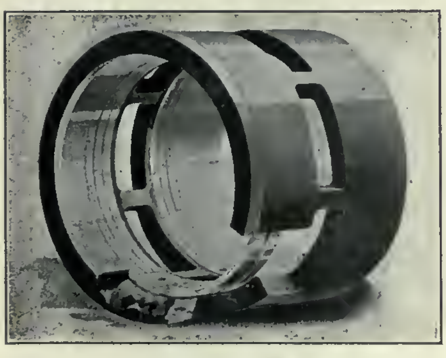


FIG. 2. VALVE CHAMBER.

FIG. 3. VALVE.

The motion, it will be observed, is derived entirely from the reciprocating movement of the pistons. Each piston causes the valve movement equal to its lap and lead on its own side, and travel of the valve in the opposite side. This diversity of movement is caused by the intervention of two rocker shafts. Valve travel, in addition to its lap and lead, is produced through the oscillation of the link which causes the radius bar, when either above or below its central position, to oscillate the rocker shafts and is effective on the side of the locomotive opposite to the link that imparts the motion. As the front end of the radius bar acts on the lap and lead lever between its two extreme connections, unusually long travel is imparted to the valve without excessive angularity to the swing of the link.

This feature alone accounts not only for a more rapid opening of the valve at the desired moment when the piston is about to reverse its movement, but also gives a much wider opening, and, relatively, a more rapid closing of the valve, than is possible in the case of valve gearing confined to a shorter valve travel. It also produces an equitable valve movement under all conditions. The events are uniform and positive. With 42 degrees link swing, the maximum valve travel is eight and one-half inches. The ratio between lap and lead may be proportioned to suit service conditions. Hence, a gain of over 40 per cent in width of steam port openings in early cut-offs is possible, and has been clearly shown by repeated indicator diagrams in trial tests.

FIGS. 2 and 3 show views of the valve chamber and valve. It will be noted that in the Young valve the packing arrangement is reversed by recessing the rings into the walls of the valve chamber in sliding contact with the valve, thus relieving the moving member of 50 per cent of its weight, the removal of the rings from the valve precluding the necessity for bull rings and followers, the valve being simply a light cylinder cast in one piece of uniform thickness throughout, provided with suitable ports for admission and exhaust with its periphery ground to accurate finish. The knuckle attachment between the valve and valve stem is for the purpose of assuring perfect alignment. It will thus be seen that the packing rings, instead of expanding to the irregular walls, are compression rings, and the valve is thereby converted into a movable plug, and its practicability is insured by the yielding contact between it and its encircling rings; and, as a consequence, friction is nearly

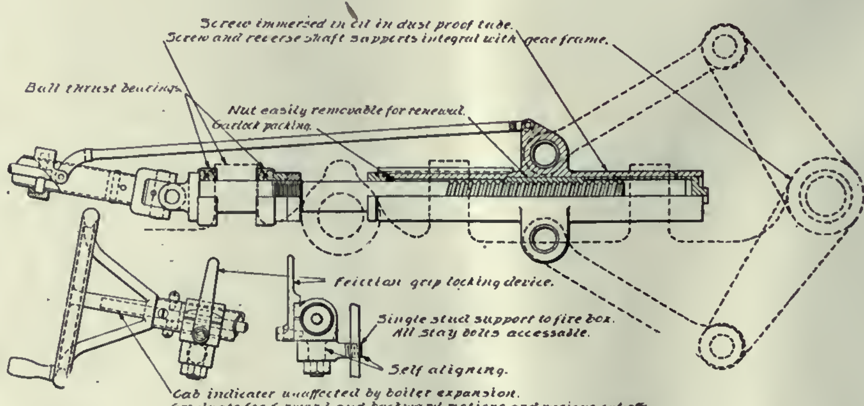


FIG. 4. SECTION VIEW OF THE REVERSE GEAR.

eliminated, and a prolonged service is secured, and considerable more of the power of the locomotive is available for draw bar pull.

FIG. 4 shows a section view of the reversing gear. The reverse shaft and reverse screw supports are integral with manipulation. The operating rod is a pipe universally jointed to the screw and thence to the operating rod, and controlled by a hand wheel in the cab. The rod and hand wheel are concentric instead of having separate axles connected by gear wheels, and as the rocking shafts of the valve gear as assembled on the locomotive, and it need hardly be pointed out that the connections are all easily reached and capable of being readily rebushed and replaced in the course of inevitable wear, and when properly adjusted retains its reliability of action in a marked

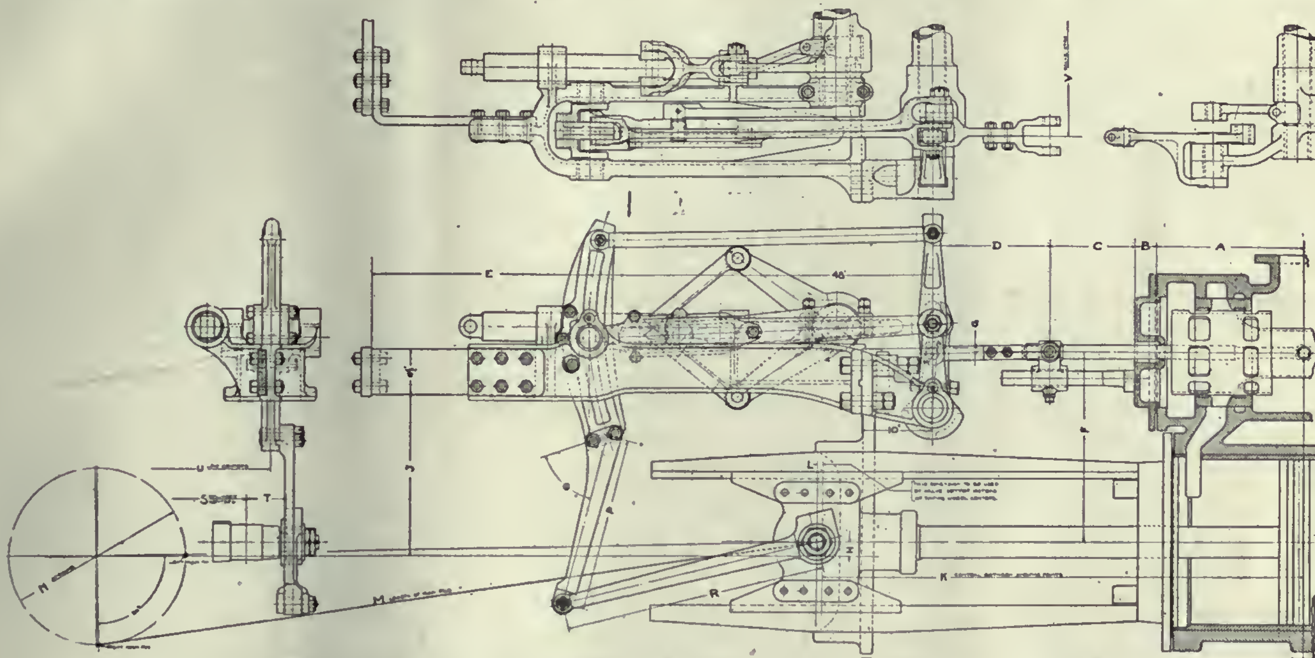


FIG. 5. ELEVATION AND PLAN VIEWS OF THE YOUNG LOCOMOTIVE VALVE GEAR

the gear frame and as a consequence positive control is maintained. The screw, which controls the reverse shaft, is immersed in oil in a dust-proof tube, insuring easy and long service and perfect action, the ball thrust bearings securing perfect alignment and aiding in the easy and their attachments balance each other exactly, the movement of the reversing screw is very easy, changes in the cut-off requiring little or no physical effort even when the engine is acting under the highest steam pressure.

FIG. 5 shows elevation and plan views degree. In the matter of starting, it may be stated authoritatively that it has been found that it is rarely necessary to slack even the heaviest train in making the initial start, and the accelerations rapid, attaining and maintaining very high speed and handle heavy trains at highest speeds.

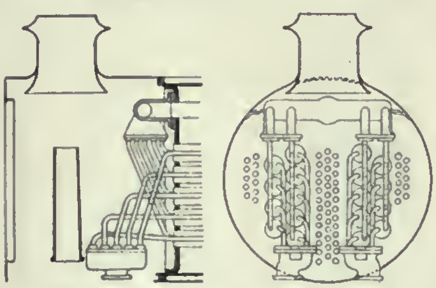
The Horwich Superheater

In Operation on the Lancashire & Yorkshire Railway

Mr. George Hughes, the mechanical engineer of the Lancashire & Yorkshire Ry., has applied a superheater to some 0-8-0 locomotives built at the Horwich shops of the company, which differs in some essential particulars from other superheaters hitherto in use.

In the ordinary type of superheater there is usually a steam header divided into two separate chambers by a partition. One of these is for saturated and the other for superheated steam. The latter flows from the header, through cast iron or welded steel pipe, down each side of the firebox to the cylinders. This arrangement is effected by placing the large tubes in horizontal rows.

In the Horwich superheater the tubes are arranged in vertical rows, and the upper header holds nothing but saturated steam, while the ends of the superheater tubes drop down towards the bottom of the smokebox, to connect with two superheater headers, one on each side of the smokebox, and each of these is in direct communication with a cylinder. This ar-



SECTION AND FRONT VIEWS OF THE HORWICH SUPERHEATER

rangement greatly facilitates the inspection and cleaning of the tubes, besides avoiding an interchange of heat between the superheated and saturated steam, when they are held in a single header with only a partition between them.

The following are some of the principal dimensions of the 0-8-0 locomotives to which these superheaters have been applied:

Diameter of cylinders............21½ in.
Stroke of piston....................26 in.
Diameter of wheels............4 ft. 6 in.
Steam pressure ....152 lbs. per sq. in.
Grate area ....25.6 sq. ft.
Heating surface ....2334.5 sq. ft.
Weight on rails..............146,300 lbs.

—*Revue Generale des Chemins de Fer.*

Hardening Screw Gauges.

The hardening of screw gauges in oil, after casing in cyanide, can be performed with less distortion than if water is the quenching medium. The temperature of 1323 deg. Fah. is the best heat for quenching at. By screwing gauges to accurate pitch and to two-thirds below high limit and one-third above low limit, lapping can be dispensed with.

Extensive Contracts of Railroad Improvements

District Estimates Submitted by the Chief Executives

From the reports that have been already submitted by the railroad executives to the Interstate Commerce Commission it appears that while a number of railroads have not yet presented their estimates, there are details of needed equipment amounting to $762,256,108 in cost, which when completed will approach to one billion of dollars for improvements on transportation lines. This outlay will be made or contracted for during the four months of the present year, and is the greatest expenditure in a similar period made by the railroads in the history of the country.

The details show that these expenditures divided between districts, show that the eastern railroads propose to spend for main line improvements and plant betterments, $128,565,523; for new locomotives, new cars and new rolling stock, $200,839,047; for expenditures not separated between road improvements and new equipment, $35,707,200, or a total in the eastern territory of $365,111,770.

Figures and statistics on the detail of the proposed expenditures indicate that the outlay for the country will be as follows: Additional main tracks, $23,012,772; additional yard tracks and sidings, $42,483,251; signals and interlocking plants, $6,767,756.

Shops and shop improvements, $43,855,408; stations and station facilities, $16,447,990; extensions and branches, $6,376,082. Other improvements, $153,465,823; locomotives, $105,616,166; box cars, $97,259,600; open top cars, $66,137,150; refrigerator cars, $24,887,500. Other freight train cars, $23,273,555; passenger coaches, $35,779,846. Other passenger train equipment, $14,395,927; all other new equipment, $12,352,309; improvements to existing equipment $44,877,773; and equipment expenditures not itemized, $9,500,000.

In the southern district the outlay for real betterments, as proposed, is $27,488,051; for new locomotives and rolling stock, $43,664,821, or a total of $71,152,872.

Railroads of the section west of the Mississippi River contemplate expenditures as follows: For road improvements and plant betterments, $292,409,082; for new traffic carrying equipment, $434,139,826. The largest item in expenditures for equipment is for locomotives. Estimates based on reports from fifty-four railroads indicates that the average cost of a locomotive is $58,660.77. As the total sum proposed for engines is $105,616,166, the carriers expect to purchase 1,800 new engines before the end of the year and of which 750 will go to the Eastern roads. The Southern roads will get 200 and the Western roads 850.

The cost of a box car is estimated at $3,000. As the roads propose to spend $97,559,000 for new box cars, a total of 30,000 cars will be added to the equipment of the carriers under this program. More than one-half of these cars will go to the Western roads. The Eastern roads will get 15,000, and the Southern roads will buy 2,000.

The construction cost of an open top car is placed at $3,000. The carriers propose to spend $66,137,150 for this type of equipment, indicating that about 22,000 new hopper and gondola cars will be added to the rolling stock of the roads. Of this number, 13,500 will go to the Eastern railroads, 1,300 to the Southern carriers, and 7,200 to the Western railroads. The outlay on box cars in the total, however, is 50 per cent more than on open top cars.

About 5,000 new refrigerator cars will be purchased. The cost of a refrigerator car is $4,622. The sum proposed for refrigerator cars is $24,887,500, and indicating that about 5,361 cars of this type are in contemplation. To this number is to be added 5,200 additional cars which two railroads are making estimates on, but have not included in the reports to the Interstate Commerce Commission. This will give the country a total of about 10,561 new refrigerator cars. Of the 5,361 new cars 1,081 will go to the railroads in the East; 1,030 to the Southern railroads, and 3,250 to the Western railroads.

The other freight train equipment in contemplation will approximate about 9,000 units at an average cost of $2,500 per unit. The average cost of a passenger coach, it is estimated, is $30,268. The railroads will spend $35,779,846 for new coaches, or indicating that approximately 1,200 new coaches are proposed for the rest of the year, and of which more than 700 will be added to the lines of the eastern carriers. Expenditures for other passenger equipment will bring this outlay up to $50,000,000.

In regard to raising the vast sums to meet this proposed expenditure, it will be recalled that as early as last March the carriers were asked to submit to the Interstate Commerce Commission the amounts which the companies expected to spend on improvements of various kinds. A revolving fund of $300,000,000 was created or set aside for this purpose, and nearly all of this fund has been already available to spend before the end of the year. The railroads expect to raise the rest of the money needed through the flotation of new issues of securities and finding a market for them through the rate advances and increases that have been granted by the Interstate Commerce Commission. As is well known the Cummins-Esch law allows the railroads a return of six per cent on the book value of their properties. The larger railroads are expected to have no difficulty to float sufficient new securities, but the smaller railroads may experience some difficulty in getting rid of their new bonds and stocks. In such a contingency the government is expected to get behind the less favored railroads and plans looking towards an equalization of profits are already maturing, as under the near system of a substantial guarantee of a fixed rate of interest doubtless some of the more prosperous cannot fail to furnish a surplus, a large portion of which will, under governmental control, be available for use in meeting such discrepancies as may arise in the accounts of the less favored roads.

Doubtless in the instance of the large railroads, it is generally believed that the securities will find a ready market, but the strong factor in the situation is the new advance in freight and passenger rates. The carefully prepared estimates are that the increases will give the roads additional revenue amounting to $1,546,951,247. These estimates are based on the volume of traffic that was carried last year. The 20 per cent increase in passenger fares is expected to yield $233,827,982; the 35 per cent increase in freight rates, $1,263,525,630; the 20 per cent increase in milk rates, $4,639,344; the 20 per cent increase in baggage charges, $1,420,000, and the 50 per cent increase in Pullman fares, $43,639,344.

It will be interesting to note in the undiscovered future how near the results will approach the expectations of the statisticians. While it is most likely that they will fall short of what is hoped for than that there should be a surplus, would only be in keeping with human experience, but with a revival of industry and, let us hope of tranquillity, the brightest and best minds are looking hopefully and cheerfully into the days that are to be.

French Railways.

The "Nord" and "Est" railway systems in France have returned to a complete pre-war service basis. In all on both roads, 1,825 miles of double-track road and 3,500 miles of single-track, 1.510 bridges, 12 tunnels, 590 buildings and signal stations had to be either partially or totally rebuilt.

"Back Numbers" in Locomotive Design

By J. Snowden Bell

The effort of a locomotive designer, which, within proper limits, is on a correct basis, is, almost always, to develop a design which will be characterized not merely by being a useful and practical one, but also one which is *new* in all respects, both general and particular. Work on these lines is, however, subject to the objection—in some cases a serious one—that the designer is, doubtless unconsciously, led to overlook or ignore features which, at an earlier date and in imperfect form, have been essayed and fallen into disuse, and which, therefore, having become known as "back numbers," are not considered worthy of attention.

Such a disposition of the latter features is, as it seems to the writer, neither reasonable nor advisable, for much can be learned from prior practice, both that which should be avoided as clearly impracticable, and that which may be improved and developed to useful and economical application. "Back numbers" are frequently interesting, and, more than occasionally, are of greater or less practical value, and to fail to deal with them, merely because they are *old,* is quite as unworthy of a capable and broad minded designer as to unhesitatingly follow the line of newer practice which may have become popular through general acceptance and not always on ascertained advantageous results.

A few instances of locomotive "back numbers" that have *come back,* or are coming back, may, without discussion of their merits, be found of interest and perhaps serve to stiffen the backbones of such timid souls as hesitate to deal with features of design which, through premature or insufficient presentation, imperfect utilization of operative principle, or for any other reason, have been shelved as unimportant or as failures in practical service. Among these are the following:

Combustion Chamber. According to the proceedings of the American Railway Master Mechanics' Association (1885), combustion chambers were applied in locomotive boilers on the Camden & Amboy Railroad, by Isaac Dripps, in 1835, and, within the knowwledge of the writer, were in service on locomotives of the Baltimore & Ohio Railroad, as late as 1863. The results of the earlier applications do not appear to have been satisfactory, and few, if any, were put in until the development of the Wootten boiler in 1877. Since that time, the merits of the combustion chamber have been so fully recognized as to result in its general approval, and it is now being applied in almost all large locomotive boilers, one on the Pennsylvania Railroad being of ten feet length. It has certainly *come back.*

Feed Water Heater. This appliance was proposed in the United States by Col. S. H. Long in 1832, and put on Baltimore & Ohio R. R. locomotives, by Ross Winans, about 1836. Very little attention was thereafter paid to it in this country, where it became virtually a "back number," although it was applied to a considerable extent in Europe, with results that can be conservatively stated as effecting a fuel saving of 12 per cent or more. It may now be said to be an element of standard European practice, and from the performance, in regular service, of the latest design which has been produced in the United States, and the trend of public sentiment as to the necessity of fuel economy, there is no room for doubt that it is *coming back,* and coming *soon.*.

Variable Exhaust. The application of the variable exhaust was general, if not universal on coal burning engines in the United States, commencing as early as 1840, and it was soon adopted in Europe, where it became and remains standard practice. Little, however, was done with it here, and, at this writing, it may be said to be a "back number." With the renewed attention which will have to be paid by railroad managers to all appliances that promote economical operation, the writer feels confident that the variable exhaust will very soon be revived in standard American practice.

Walschaert's Valve Gear. Introduced in the United States by William Mason, of Taunton, Mass., in 1874, and applied by him and others, at that time and soon thereafter, became, very soon thereafter, a "back number," in the fullest sense of the term. Within a few years past, however, conditions have been completely reversed; the standard Stephenson link gear has been abandoned; and the Walschaert's type gear, under various structural modifications, is now universal.

Short Smoke Box. Some time in the early sixties, it was imagined, and seriously maintained, by many whose opinions commanded respect, that the then existing short smoke box was all wrong, and that a long or extended one would act as a spark arrester, promote combustion, and, regardless of its manifest error of principle and objections in practice, be a great improvement in locomotive design. The craze for extended smoke boxes spread rapidly, and for many years the railroads of the United States continued to cheerfully transport useless extra weight on the front ends of locomotives; to throw practically as many cinders as before; and to impair the steaming qualities of their locomotives, by the application of smoke box extensions, which sometimes reached as far as the front of the pilot. The short smoke box became a "back number." A reasonable view of the subject has recently indicated the fallacy of the smoke box extension, and the old short smoke box has *come back,* and is now becoming the rule, instead of the exception. In the standard practice of two of the leading railroad systems of the United States, the smoke box does not extend beyond the front of the saddle, and in that of many others, only slightly beyond it.

Three Cylinders.—Introduced in the United States, on the Philadelphia, Wilmington & Baltimore Railroad in 1848, and successfully operated, this design has been reproduced here only to the extent of four locomotives in 1880, three in 1894, and four more between 1909 and 1912, after which it apparently became a "back number" with us, although extensively applied in Europe. From illustrations and descriptions in current railroad journals, it appears that "The North Eastern Railway (of England) has recently built and placed in service some of the most powerful freight engines used in Great Britain," these being of the 0-8-0 type, and that the latest instances of the development of heavy freight power in German practice, are the Class G-12 (2-10-0) locomotives. Both the English and the German engines referred to are of the three-cylinder type, and, therefore, their designers have recognized its importance and value. We have not yet withdrawn it from the category of "back numbers," but the writer feels sure that a designer will be sufficiently forcible to do so, with credit to himself and benefit to the railroads of the United States.

Superheater. The latest and most important improvement in locomotive design —the superheater—is a striking example of a "back number" that *came back.* It became a back number for the reason that it came *too early in the game;* railroad men were not prepared to grasp the far-reaching possibilities of so radical a departure from then existing practice. Originated and put in practice in France, between 1845 and 1850, it, at that time, failed to be appreciated, and no further applications of it were made for more than twenty years later, after which lapse of time, the efforts and abilities of engineers who recognized its great importance and improved it in structural detail, brought it to the front, and secured its practically universal adoption. No locomotive of any substantial size is now built without a superheater, and none should be, and the application of a superheater is the leading feature of the modernization of every old locomotive.

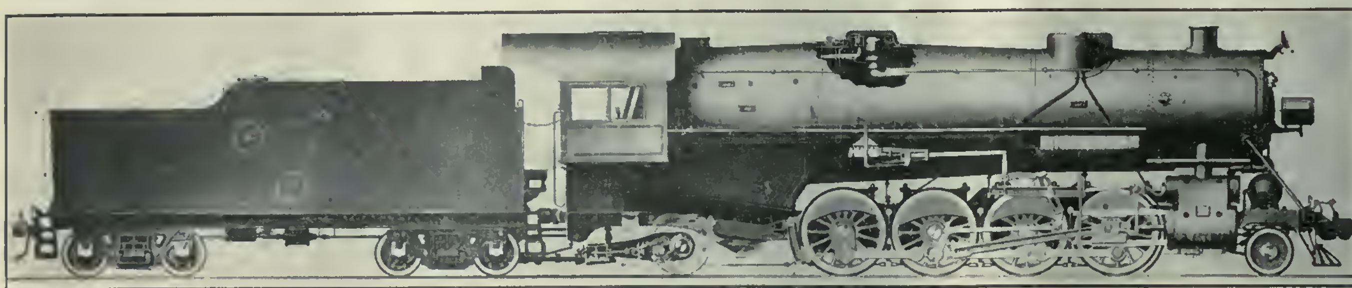
Unless the designer starts his work on the general basis that "there is nothing new under the sun," and works for *results,* rather than novelty, he may be confronted by a "back number," not dead but sleeping and capable of being a successful competitor of later proposed improvement.

The Locomotive Booster

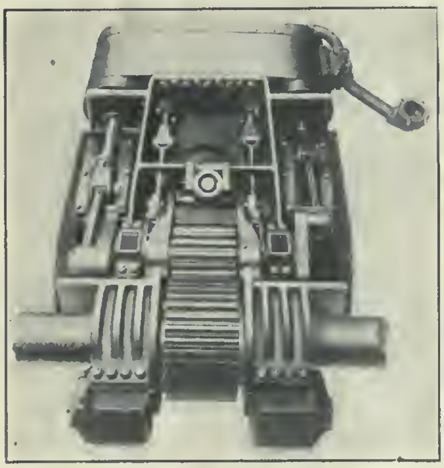
Details of Its Construction and Application—The Importance of Its Economical Value

A growing interest in what is spoken of as a booster for locomotives gives every assurance to the introduction of a device of this kind, because, as is well known, the starting of heavy trains and the passing over certain grades, especially the latter difficulty, frequently involving the use of a helper locomotive, may be in a great measure eliminated.

The loss consequent upon powerful locomotives running long distances on a level track with comparatively light trains, and never exerting their full power until the steepest grade is reached, is very great. The necessity of frequent stoppages when such difficulties are reached, and the occasional breaking of loads is not in the interest of economy, and the need of such a device as is referred to is obvious. That the Mallett locomotive has such a provision in its adaptability to use steam at a high pressure in all of its cylinders when necessary and to use its compounding appliances when on a level, straight track is its chief advantage. Its cost, however, is a matter of serious consideration in these days of multiplying prices of material and fuel. The light detachable booster-motor will, to a considerable extent, obviate the element of high cost.



LOCOMOTIVE BOOSTER APPLIED TO A 2—8—2 LOCOMOTIVE



TWO-CYLINDER ENGINE GEARED TO THE TRAILER AXLE

The Locomotive Booster invented by Howard L. Ingersoll, assistant to the president of the New York Central Railroad, may be briefly described as a power unit applied to the trailing wheels which, by utilizing their adhesive weight, increase the drawbar pull by 25 to 40 per cent (depending upon the type of locomotive) at starting and getting up road speed, and disengages automatically when the engineer hooks up the reverse lever. It capitalizes idle weight and spare steam with negligible addition to the weight of the locomotive, and without increased demands on the engineman. Its control is semi-automatic, giving the engineman maximum resource and a negligible minimum of attention to its operation.

Locomotives recently built employ weights bordering on the limit the track structure will bear. Yet their speed-pull curves nearly coincide with those of lighter engines of the same type. Greater starting and accelerating power is the principal advantage. The Locomotive Booster gives an increase in starting and accelerating power equal to what 50,000 lbs. additional locomotive weight would give. And the Booster weighs only 3,500 lbs. It avoids large investments for improved roadway and bigger locomotives.

It reduces by one half the time required to get trains to road speed. It pays its own fixed and maintenance charges several times by avoiding slipping drivers and the consequent wear and tear on the main locomotive. When the train is up to road speed it has no more effect on the locomotive's operation than so much coal on the tender.

Description

The Booster consists of a simple two-cylinder steam engine, secured to and supported by a special designed cast steel bed plate, manufactured by the Commonwealth Steel Company. This cast steel bed plate contains the axle bearings and supports all moving parts of the Booster.

Three-point suspension is provided, two bearings fitting on the trailing axle, and a third, which is a ball joint, fitting on the back member of the trailing truck frame. This suspension gives sufficient flexibility to compensate for any torsional movement between trailing truck frame and axle and in addition the ball joint is located near the center of gravity of the booster engine, thereby relieving the trailing axle of the weight and minimizing wear of the Booster bearings.

The piston rod, connecting rod and crankshaft follow general locomotive practice. The crankshaft and driving piston are integral and are of heat treated steel, liberally designed. Lubrication is taken care of by enclosing the entire engine and connections in an oil-tight steel case and using splash method. This automatically lubricates all bearings except the main bearings on the trailing axle, which are lubricated in the same manner as is employed for car journal boxes, i. e., a waste packed oil box.

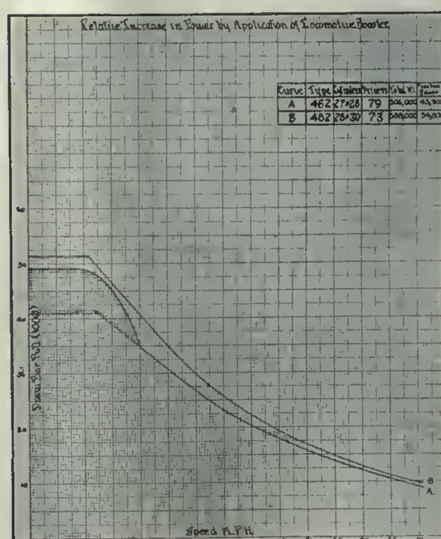


FIG. 3.

Operation and Control

The control valves are air operated, designed and manufactured by Westinghouse Air Brake Company. Practically push-button control is provided. Nothing is left to judgment except the use of the device when needed. All the engineer has to do is to raise the latch on the reverse quadrant. Operating the locomotive in the usual way automatically operates the Booster. It can only be brought into operation when the latch on the reverse lever quadrant is in operating position, when the main locomotive throttle is open, the reverse lever in the corner and when the locomotive cylinders are getting steam.

After steam is admitted to the cylinders the crankshaft pinion transmits its power through an idle gear to the trailing axle. Hooking up the reverse lever two notches or more automatically disengages the Booster and brings it to rest. The two curves, Figs. 3-4, show the effect of the Booster applied to 4-6-2 and 2-8-2 type locomotive. The Booster puts any locomotive with trailing wheels into the next class above in starting effort because the trailing wheels act as an additional pair of drivers.

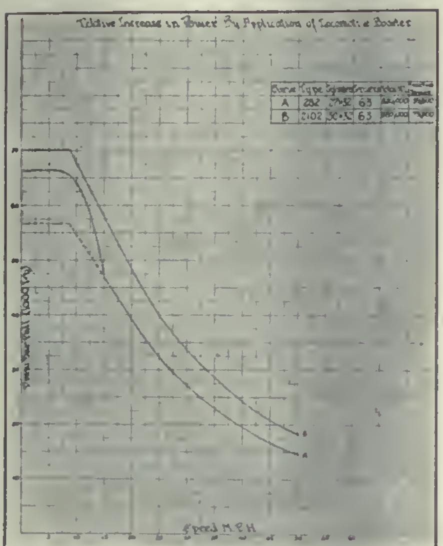


FIG. 4.

On freight trains this means more tons per train because of greater starting effort and avoids damage to equipment because of a smooth, steady start. On passenger trains it means smooth starting and quick acceleration to road speed. This adds to the comfort of the traveling public, protects the equipment from damage and renders schedules more easily maintained by avoiding delays in starting.

Water Hammer.

Anyone having occasion to open steam pressure on a long pipe range is conversant with this phenomenon. Its effect varies widely in intensity and occasionally serious results arise. It is caused by the pressure of water in a horizontal or slightly inclined pipe length and occurs when the water does not completely fill the pipe, but presents a free surface over which the steam rushes at a high velocity. If in any way the surface is disturbed so that a wave is formed filling the pipe at one place, the steam space beyond becomes isolated, immediate condensation of the steam contained therein ensues, and a vacuum is thus formed. A very large pressure difference is thus created which impels the wave forward at a high speed. The wave may be arrested by any obstruction, such as a valve, a flange, a bend, or a water mass, but its arrestment entails the establishment of severe impact pressures. When the blow occurs on a water mass it is transmitted to the pipe by a wave of pressure traveling with the velocity of sound. The severity of the water hammer blow depends upon the size of the wave set up, the unobstructed length over which it passes, and upon the elasticity of the pipe materials. The relation between the dimensions of the wave and the free space necessary for the attainment of breaking stresses differs somewhat from what might have been expected. It has been estimated that a wave 4 ft. long in a cast-iron pipe under a pressure of 100 lbs. per square inch would only have to travel through a vacuum space of 1 ft. length in order to cause fracture. With copper and steel pipes the free lengths for the same wave would be 10 ft. and 7 ft, respectively, but with these the more ductile materials might only suffer distention. Whilst water hammer arises from the presence of water it is actually caused by some extraneous action, such as the opening of a valve or drain cock. As the majority of failures are due to water hammer caused by attempts to drain the pipe, the arrangements for that purpose deserve careful consideration, both in design and manufacture.

What a Horsepower Means.

To lift 550 pounds one foot in one second requires what is known as one horsepower, says an exchange. Similarly, a horsepower is able to raise twice that weight one foot in twice the time, or one-half foot in just that time. Moreover, it can raise half 550 pounds one foot in half a second, or two feet in a second, and so on. Therefore, when we lift one-fourth of that weight, 137½ pounds, four feet in one second, we are exerting a horsepower.

Accordingly, when a person who weighs 137½ pounds runs upstairs at the rate of four feet a second, he is exerting the equivalent of a horsepower. For a man weighing twice that much, 275 pounds, it would be necessary to climb at the rate of only two feet a second to exert a horsepower. It is possible to do much more.

As a matter of fact, a horse often exerts many times a horsepower. The average horse can draw a wagon up a hill where a ten horsepower engine with the same load would fail. A horsepower does not represent the greatest momentary strength of the average horse, but is a measure of the power which he can exert continuously.

Peat as Fuel in Swedish Railways.

Interesting trials to test the possibilities of peat as fuel for locomotives have been in progress for some months on several railways in Sweden. The reports so far show favorable results. One privately owned railroad in southern Sweden, 256 miles in length, has found peat so practical for steam purposes that the management believes the road can dispense entirely with coal. The State Railways have likewise been testing peat for steam purposes, with good results, and have on a limited scale adopted it for fuel. For some years the State Railways have been operating a factory for the production of peat powder, which is said to make an excellent fuel.

In Sweden, where there are 10,000,000 acres of peat bogs, with an average depth of 6.6 feet, the substitution of peat for coal would add enormously to the national wealth. Every acre of peat bog yields nearly 1,000 tons of prepared peat.

The Advantages of Early Training.

In urging the advisability of well-educated young men turning their attention to industrial occupations, a leading manufacturing corporation, in pointing out the growing field relating to oxy-acetylene and related industries, states that the man who goes to the top in a great organization is the man who has had the advantage of a thorough scholastic training. The trained mind assimilates a wider range of things, recognizes the real forces and understands their relation to each other and to the whole. He steps out of the routine job into the administrative and executive realm. The trained mind achieves in a few years what the untrained mind can never attain. The only seniority in a great unfolding business is the seniority of the trained mind.

The development of the oxy-acetylene and related industries is one of the romances of American business. Almost unknown fifteen years ago, it has become one of the stupendous achievements of the times. Carbide, oxygen and acetylene today enter into almost every branch of industrial life in the world. Their applications go hand in hand with the metals everywhere, and they are being constantly extended. Few fields of human endeavor afford greater opportunity for material advancement of the men in the industry and business of the country; few are so engaging in interest, so stimulating to ambition. In the great corporations at the forefront of the industry are thousands of successful men and no inconsiderable number who have amassed large fortunes. Everywhere in the organizations ability is given recognition and a merited reward. Distinction and fame, as well as affluence, are to be earned within the bounds of this wonderful emprise.

Details of Parts of the Pacific Type Locomotive as Shown in Our Chart, No. 12

The Throttle Lever.

We present herewith the last of the essential details of the chart of the Pacific locomotive that was published last winter. Nearly all of the remaining parts that have not been published among these parts belong to the list of manufactured specialties. This last to be described is the throttle lever and its immediate attachments.

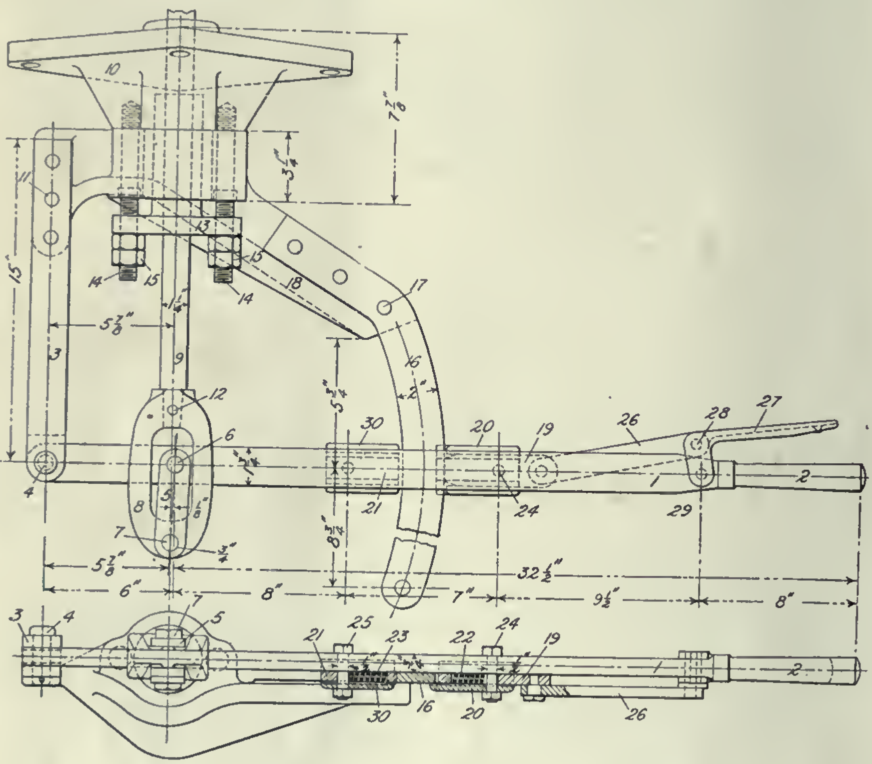
The lever (1) itself is 38½ in. long over its handle (2), which is 8 in. long. The lever is pivoted to the fulcrum (3) by the bolt (4), which fulcrum is rigidly attached to the boiler through the throttle stem stuffing box (10), to which it is fastened by the fulcrum bolts (11). This causes all parts of the lever to move in the arc of a circle when it is moved. Hence it is necessary to make a flexible connection between the lever and the throttle stem (9), as the latter must move in a straight line. This connection is formed by means of a link (5) that is pivoted to the pin (6) attaching it to the lever, and to the pin (7) attaching it to the yoke (8) of the throttle stem. The stem itself is fitted into the yoke and held by the taper pin (12).

The throttle stem passes through the gland (13) and the stuffing box, and thence through the upper part of the boiler to the throttle valve where it connects with the crank arm of the same. The gland is held in position and against the packing by the bolts (14) and nuts (15).

Cast to the stuffing box, on the opposite side from the fulcrum, is a bracket (18), to which the quadrant (16) is fastened by the bolts (17). The quadrant is notched on one side for the reception of the latch (19). This latch is held in place by the guide (20) which is fastened to the lever by the bolt (24), and is held out or down in the notches of the quadrant by the spring (22). When the latch is down in the notch of the quadrant, the throttle lever and, with it, the stem and valve are held rigidly in place, and can only be moved by first lifting the latch out of the quadrant notch. This is done by means of the latch handle (27) and the link (26). The handle is L-shaped and is pivoted to the lever at the end of its short leg by means of a bolt (29). It is also connected to the link by the pin (28). It is evident that when the latch handle is drawn towards the lever handle (2) the link (26), and with it the latch, will be moved to the right and drawn away from the quadrant, so that the lever will be made free to move. When it has been moved to the desired position, the handle is released and the spring (23) will push the latch down into a quadrant notch, draw the handle into the position shown in the engraving and again lock the lever.

On the concave side, the quadrant may be corrugated with shallow corrugations. Into these the drifting latch (21) is pressed by the spring (23). This latch, like the throttle latch, is held in place by the guide (30) which, in turn, is fastened to the throttle lever by the bolt (25).

The following is the list of parts entering into the construction of the throttle valve:



DETAILS OF THROTTLE LEVER AND ATTACHMENTS

List of Parts.

1. Throttle lever.
2. Throttle lever handle.
3. Throttle lever fulcrum.
4. Throttle lever fulcrum pin.
5. Throttle lever link.
6. Throttle lever link pin.
7. Throttle stem yoke pin.
8. Throttle stem yoke.
9. Throttle stem.
10. Throttle stem stuffing box.
11. Throttle lever fulcrum bolts.
12. Throttle stem and yoke pin.
13. Throttle stem gland.
14. Throttle stem gland bolt.
15. Throttle stem gland nut.
16. Quadrant.
17. Quadrant bolt.
18. Quadrant bracket.
19. Throttle latch.
20. Throttle latch guide.
21. Drifting latch
22. Throttle latch spring.
23. Drifting latch spring.
24. Throttle latch guide bolt.
25. Drifting latch guide bolt.
26. Throttle latch link.
27. Throttle latch handle.
28. Throttle latch handle and link pin.
29. Throttle latch handle pin.
30. Drifting latch guide.

Welded Tanks.

It should be more generally known that tanks welded by the oxy-acetylene process are being built very extensively in many parts of the United States, and they are at once so economical and so satisfactory that they are very largely displacing riveted tanks. They withstand very much greater pressure than the water pressure in the riveted tank, and after proper test and inspection are accepted everywhere as the highest type obtainable in tank construction. Welded joints can be repaired very easily and effectively by the oxy-acetylene flame, though the occasion for such repairs, as welded tanks are now constructed, is practically uncalled for.

Snap Shots By The Wanderer

When a good housewife plans or looks for a house, the closet room is apt to be the first consideration, but when the architect does the planning he is apt to forget the closet and make his great display in the front porch or the entrance hall. So it seems that the designers of some of the latest river and lake steamers have made their great display in the saloons and forgotten the convenience that might have been put in the staterooms at little or no expense and which would have added mightily to the comforts of their occupants. I have traveled on one certain line for—well more years than I like to mention, and have seen its boats grow from toys to "floating palaces," and have seen the lights in the staterooms, come up from there being none at all to a fine electric bulb. In the meantime little comforts have crept in. There was a chair, a shelf for toilet articles; the mirror conveniently located, a window and shutter that persons of short stature could manipulate and a comfortable bed. Then steamers of the latest type were built. Designed for the constructor without keeping the passengers' comfort in view. The mirror was placed opposite the basin so that one has to stand leaning sideways to use it. The chair was replaced by a folding seat fastened to the wall at a point most inconvenient for use. The window was made to drop and had its fixture so high that it needed a giant to reach it. The door had a spring lock and passengers are obliged to make a constant demand on the stewards for unlocking, and worst of all from the standpoint of the women, the little toilet shelf has been omitted and there is no place to put hairpins and curl papers. And that is such a heinous offense in the eyes of some, that the line has actually been boycotted by more than a few on that account. The strange part of the thing is that after taking years to develop the little stateroom conveniences that they should be wiped out of existence at one fell swoop because the naval architect who designed the boat did not happen to think of them, and then, that after having omitted them the company does not care enough to ask their own stewards as to what the passengers think. If it did, some very wholesome and profitable truths would be garnered in.

And that reminds me, why don't people go to men at the bottom of the ladder more than they do for information. The story is told of an engineer who was noted for getting at the gist of matters, that he was once called in to the office of a superintendent of motive power, and started on an investigation. At the end of the interview, the engineer said that he thought he understood what was wanted and probably would not have to trouble the official for any more information until he rendered his report.

"No, I don't suppose you will," said the S. M. P., "but I expect to hear of you interfering with the men and hobnobbing with the dirtiest and greasiest you can find, at the cinder pits and roundhouses, and pumping them dry, all of which duly sifted, I will receive in a neatly typewritten report."

And I rather expect that is exactly what he did get.

The late J. W. Marden, the veteran master car builder of the Fitchburg Ry., in speaking of his own early experiences, said that he went to the shops of the Fitchburg to learn carbuilding. That was in the days of the 10-ton car and 10-ton load. To his disappointment and somewhat to his disgust, he was put to work in the boneyard. He stood it as long as he could and then went to the master carbuilder and said that he had come there to learn carbuilding and wanted to know when he was going to have a chance.

To him the master carbuilder: "My boy, you are in the best place in the world to learn carbuilding. You can learn to use a hammer and saw anywhere, but it is in the boneyard that you can best study the good and bad points of car construction and design. Go back and open your eyes. Learn the weak and strong places of the cars that come to you for repairs. See where wear and breakage takes place and remember what you have to do to fix it. The work is dirty and unpleasant, but the opportunity to learn is unsurpassed if you will but learn to observe as well as to see."

Needless to say, Mr. Marden took the advice, and to the end of his days he said that he regarded his scrap heap as the most reliable and valuable source of information. Strange in what poor esteem the scrap heap is usually regarded.

When he said, with a complacency most admirable, that he was a mechanical engineer, a civil engineer, a lawyer and an accountant, it was most natural that one should think of the old proverb of the Jack of all trades. But when he proceeded to show mere practical experts, in their lines, how to sweep the floor, dress a tool and grind a throttle our admiration knew no bounds.

"And still we gazed and still the wonder grew.

"That one small head could carry all he knew."

And yet despite it all we could not suppress the query that kept coming back, as to why it was that this combination of quasi professional accomplishments should have rendered him competent to act as an efficiency engineer. I had written "pose" instead of "act," when it occurs to me that to "pose" was exactly what he was fitted to do and that he was doing most admirably. Still, while one has a sort of pitying contempt for that kind of business, it cannot fail to arouse a certain amount of admiration for the boldness that rushes in where angels fear to tread and the self confident assurance with which every job is undertaken. Then behind it all comes the puzzling part to solve, as to how such a man can impose his services on any man however ignorant he may be of things mechanical and how it comes that such a man can be taken seriously to make a recommendation for the management of a plant.

It is related that Watt once wrote to his partner a self-congratulatory letter in which he said that he had made a piston fitting so closely into the cylinder of an engine that a half crown could not be dropped between the two. This state of affairs was followed by continually increasing improvements, until the steam packing rings were about the most expensive items in engine construction, when someone asked, "what's the use?" and straightway we find locomotive superintendents dispensing with steam packing, follower-plates, springs and a miscellaneous et cetera, and the heaviest engines are now running with ⅜ inch cast packing sprung in.

There is one thing in regard to which American manufacturers are woefully hard-headed and slow to catch on, to use a bit of slang. It is well known that the condenser will save from fifteen to twenty-five per cent. of the fuel used on the non-condensing engine; that it is almost entirely self operating; that it requires a minimum of attention and that there is hardly a plant in operation to which it cannot be cheaply applied, and yet there is no one thing that is so difficult to sell to the average owner as a condensing apparatus. You may calculate with him that burning a ton of coal a day at three dollars a ton his fuel is costing him about nine-hundred dollars a year; that twenty-five per cent. of this is two hundred and twenty-five dollars; that a condensing apparatus will cost him about six hundred dollars, and that, including interest, it is more than paid for in three years. He looks bored, smiles complacently upon you as a harmless sort of an enthusiast, says he will think about it and straightway proceeds to forget all that you have said. Why is it?

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A New Era in Railroad Transportation.

It is not too much to say that the dawn of a new era in railroad enterprise is upon us. With the liberal action taken by the Interstate Commerce Commission in the matter of allowing such rates as are calculated to produce a just and reasonable rate of interest to those who are the real owners of railroad property, there is a guarantee that new investors will be forthcoming to guarantee not only the needed improvements in equipment, but the means of extensions into new and undeveloped territories. It is a sad commentary on our boasted civilization that in this mighty republic, with its unbounded natural resources and enterprising population, guided by the highest engineering skill, changing the pathless wilderness in a comparatively short cycle of years into cultivated fields and expanding cities that are the wonder and admiration of the world, should have been unable to develop a transportation system commensurate with the requirements of commerce.

Setting aside the disturbing effects of the European war, from which we emerged triumphantly, and during which the best system of transportation could not be other than seriously disturbed, it will be universally admitted that other causes long antecedent to the war kept the American railroads on the ragged edge of bankruptcy. The work of the early pioneers frequently fell into the hands of unprincipled speculators with their stock-watering proclivities. Legislatures had to be bribed before enterprises of great pith and moment could be proceeded with. Rival railroad builders ran each other into ruin. Concessions were granted into regions that never paid and never will. The utter lack of governmental control opened the door to a competitive rebate system that ended in the larger corporations swallowing up the smaller. Capitalists were naturally alarmed, and shippers and the traveling public who had to pay the price of all the shady transactions became unreasonable in their denunciations, blaming alike the just and the unjust. Into this maelstrom of mismanagement came the Interstate Commerce Commission, apparently actuated by a spirit of revenge, visiting the iniquities of the fathers upon the children or successors of them who had brought about this condition. And it should not be so much a surprise that development was cramped as that we got along as well as we did, for in spite of it all railroad transportation continued to be cheaper in America than in any other part of the world.

The repressive measures adopted by the Federal and State Commissions, however, not only checked enterprise and kept wages at a low ebb, bringing on discontent and a spirit of unrest among the industrial classes, finding vent in ruinous strikes, and superinducing unreasonable demands, but creating what may be classed as a revengeful spirit of a determined neglect or inactivity in production, fatal alike to employer and employee, in that spirit of mutual helpfulness which ought to actuate all engaged in a common enterprise.

We are hopeful of having seen the end of this as far as the railroads are concerned, and to our vision there has come the light of a better day when mismanagement, misgovernment, or, rather, the lack of government, will have passed away, and our transportation system will, in the fulness of time, reach that degree of perfection in promptitude and safety commensurate with our national requirements.

Water Gauges

The report of the Bureau of Safety on its investigations into water glass and water gauge indications is probably the most valuable that has ever been issued by the department. It handles a matter of far reaching importance to every one who has to do with the operation of a locomotive boiler and, for that reason, as well as for its intrinsic value, it is published almost in full. It shows a condition to exist, under operating conditions, that many have, in part, suspected but of which no one had any definite information. We have all known, or thought we knew, that the water rose when steam was drawn from the boiler in large volumes, but our idea was usually to the effect that, while this rising might be greatest at the firebox, it was practically uniform over the whole water surface. But few, if any, suspected that the rising was insignificant anywhere except against the back head and that, there, it took the form of a wave or bank whose top might be 8 or 9 in. above the general water level, a few inches ahead and over the crown sheet. We have known that the gauge cocks usually indicated a higher level than the glass, but thought the glass to be at fault; because, if the cocks showed water, why water must be there and that must be the level. Or if the rise was exceptionally high, at starting as from one gauge to three, then we thought the boiler was foaming. And all of these ideas were founded upon our belief that gauge cocks could not lie.

The investigation under consideration has shattered these long entertained ideas and shattered them very badly. They show the gauge cock, as usually applied, to be the most unreliable of indicators, and it is surely something of a shock to be shown that an instrument upon which we have placed implicit confidence for a hundred years is worthless for the purposes intended.

And, now, as we look back upon it, we can see that it has undoubtedly betrayed our confidence thousands of times.

Of locomotive boiler failures the failure of the crown sheet is the most common, and crown sheet failures in, we might say, nine hundred and ninety-nine cases out of a thousand are caused by low water. One superintendent of motive power of life-long and extensive experience, recently said that he had never known, personally, of a locomotive boiler failing from any other cause. Another engineer who has investigated and reported on forty-three locomotive boiler failures, says that, of these, two were shell explosions, one a firebox failure due to broken stay bolts and the balance were low water failures. And there is very little chance of an erroneous report being made as to the cause of a boiler failure. The wreck writes its story so plainly and vividly that anyone can read it who will; and, if low water is the cause, the signs are unmistakable. There can be no mistake.

Men of long experience and certain reliability have burned their sheets or had a crown sheet come down, and they have invariably protested that they had two gauges of water; and we, in our ignorance have laughed and said: "Of course he says so." And now it appears that, like the vigilance committee who hanged the wrong man, the joke is on us. These engineers undoubtedly thought they had two gauges of water, and had good reason for thinking so, because the gauge cocks had said that they did, and they believed what the lying gauges had told them. Now it appears that there may be solid water flowing from the third gauge, and the front end of the crown sheet be bare. Surely that is a startling revelation. A revelation which means that hundreds of men have been killed and crippled because we did not know how to make a proper application of water glasses and gauge cocks to our boilers. If the investigation had stopped there, we would have been in a perilous condition indeed, for it would have left us in desperate straits. It has shown that gauge cocks screwed into the back heads are worthless and that the usual application of the water glass connections is not much better. But it has also taken a constructive turn and shown how these two implements of water level indication can be applied and tell an accurate tale within a small fraction of an inch. The water column with water glass attached is the solution. A short connection at the bottom away from the direct action of the arch tubes and a large top connection reaching over and entering the roof sheet well ahead of the back head so as to insure a steam connection, and so made that it drains both ways with no sag, loop or trap, and we have a pair of water level indicators where the cock will tell the same story as the glass and neither will be a half inch away from the true level over the crown. That this is so gives us breath after the shock of the other. But it means a rapid revision of present methods, and no rapidity can be too great to meet the necessities of the case. It is one literally of life and death and it will be an instance of criminal neglect if there is a day's unnecessary postponement of the application of so simple a remedy to so important a defect.

"Snow Burnt" Rails.

Particular attention is being drawn to the report of the Chief of the Bureau of Safety in regard to the breakage of rails, causing a derailment of a passenger train on a western railroad. One rail on each side of the track was fractured, one being broken in two pieces and the other rail into four pieces, each haivng been burnt practically its entire length. The term snow burnt, as is well known, refers to the season of the year and to the effects of the slipping of driving wheels, which abrade the top of the rail, cause intense local heating, and result in the formation of shallow zones of hardened metal next the running surface.

The report leaves little doubt concerning the responsibility of the derailment to the wheel-burnt condition of these rails, and it is a matter of importance to acquire data which shall illustrate phases through which the steel passes and specifically explain the manner in which rupture is reached in cases of this kind. The present report will be considered as a progress report upon this important subject. It was apparent that the slipping of the wheels distorted and scored the metal at places along the running surface, slightly hollowing the head in spots. Intense hardness of the metal was imparted, covering areas of one or more square inches. The edges of these areas were more or less ridgy or rippled. The metal was dragged by mechanical abrasive action, heat generated by frictional resistance, and the surface hardened by sudden quenching through conductivity of the cold metal below. Experiments showed that the intense degree of hardness did not extend much over one-sixteenth of an inch in depth, although in some intances it extended nearly over the entire width of the head of the rail. Longitudinal cracks were discovered in some instances separating the hardened metal and extending into the normal structure below the hardened zone. The fragments of the broken rails showed lines of rupture having their origin at the running surface, thence extending downwards through the head, web, and base.

The suggestion that wheel-burnt rails should be indiscriminately removed from the track would not appear justifiable in view of the inadequacy of the data upon their condition and the large number of such rails that are carrying present equipment without rupture. The fact is that the means of distinguishing between safe and unsafe rails has not been made known. It invites attention to relevant features, while further investigative work on the subject is, we understand, already in progress.

Stainless or Rustless Steel.

Stainless or rustless steel consists essentially on an alloy of iron and chromium, containing usually 0.1-1 per cent. carbon and 12-14 per cent. chromium. It is produced in crucibles or electric furnaces, owing to the tendency of the chromium to oxidize at the melting point. The metal is cast in the usual manner into ingot moulds, and the ingots are forged or rolled into bars or sheets. The material can be forged fairly readily into various forms if heated to a bright orange temperature; and if after forging the metal is allowed to cool in air, it will be found to possess good cutting qualities. Quenching in water enhances the hardness to a considerable degree, especially if the steel contains more than 0.4 per ent. carbon, but oil quenching gives the best results. This steel resists formation of scale during forging to a great extent, and is therefore adapted to high-temperature uses, such as engine valves, distilling apparatus, etc. When ground and polished the material resists tarnishing to a remarkable degree. It is slowly attacked by dilute or strong sulphuric and hydrochloric acids, practically unaffected by nitric acid, and is unaffected by nearly all the fruit acids and strong vinegar.

Increased Rates and Prices of Commodities.

The general apprehension that there will be a considerable increase in the price of commodities on account of the increase of railroad rates is one of those fears that arise from past experiences rather from a real need of an increase in prices. The added costs of transportation is almost an invisible quantity when examined in detail, as for example the item of clothing manufactured in New York or New England and forwarded to cities along the Gulf of Mexico, the rates for the last year were between $1.50 and $1.60 per 100 lbs. The new rate approaches $2.10 per 100 lbs., which, in all fairness, would add from 12 to 15 cents to the price of a suit of clothes. It will be interesting to note by what method of calculating the public can be mulcted to a greater extent in this item or any other commodity, but the ways of the unprincipled profiteers are past finding out. They should promptly be fined or confined.

Molybdenum in Steel Making

A prominent American metallurgist states that ferromolybdenum is added in a fixed condition. It is supposed to give the steel properties similar to those of tungsten steel, but only one-third to one-half as much molybdenum is necessary; that where regular, high-speed steel contains 18 per cent. tungsten, 6 to 9 per cent of molybdenum may be substituted. However, it gives these properties only when the addition is properly made and proper heat treatment follows. The regulation of these factors caused so much trouble and expense that, in the United States, the manufacture of molybdenum high-speed tool steels has been practically discontinued for several years. It is used for this purpose in other countries, however, to a considerable extent. At the present time it is mainly employed in tool steel as an auxiliary rather than as a major constituent. Various reasons have been assigned for the discontinuance of the use of molybdenum.

Urgent Need of Improved Water Gauge Appliance

Crown Sheets Endangered by Unreliable Devices

Owing to many failures of locomotive crown sheets due to low water the bureau of locomotive inspection of the Interstate Commerce Commission has carried out a series of tests for the purpose of determining the accuracy of the ordinary methods of water level indication and of ascertaining the best arrangement of the cocks and glasses to accomplish perfect accuracy of indication.

It was found that the water glasses and cocks, as generally applied, only indicate a corresponding level of water, while the locomotive is at rest with no steam escaping, but when the safety valves lift or with the throttle valve open and the locomotive in operation, the gauge cocks, when applied directly in the boiler, indicate a higher level of water than do the water glasses when they are properly applied and maintained. This discrepancy between the registrations of these devices has, heretofore, been taken as a matter of natural consequence, and little consideration given to the cause or the result of the conflicting registrations, one or the other of which must be wrong.

Practically all enginemen and others having to do with the operation of the locomotive, true to a common understanding, believe that the correct height of water over the crown sheet is always indicated by the gauge cocks, and that the level indicated by the water glass is unreliable and not to be depended upon, therefore, it is reasonable to believe that enginemen have frequently depended upon a level of water indicated by the gauge cocks as being correct, when in fact the true level was much lower, and, as a consequence, damaged crown sheets have resulted.

With this thought in mind, and realizing that this variation creates an unsafe condition and that its cause should be determined and a remedy applied, experiments have been made with different devices, on a number of locomotives of different classes, on fourteen railroads in various sections of the country, for the purpose of determining the action of the water in the boiler and its effect upon the gauge cocks and water glasses.

The locomotives of the first series of tests were of the Mallet type, with wide fireboxes, superheaters and burning oil. The water level devices were three gauge cocks spaced 3 in. apart applied directly in the back head near the knuckle, at right angles to the sloping sheet, and one water glass with bottom connection entering the back head approximately 3 inches between the back end of the crown sheet, and the top connection entering the back head 2 inches below the knuckle. The lowest reading of the water glass and gauge cock was 3⅝ inches above the highest part of the crown sheet.

The back heads of these boilers were braced by a "T" iron, extending crosswise, at approximately the same level as the back end of the crown sheet.

Observations were made on five trips of freight service covering about 680 miles.

With the locomotive on straight track and no indication of foaming, water would issue from the top gauge cock when it was opened, both while standing and in operation, while the safety valves were open or the throttle valve open, regardless of the water level in the boiler as registered by the water glass.

At the completion of the fifth trip, three additional gauge cocks were applied in the back head, parallel with the horizontal center line of the boiler, the top one entering back head 10½ in. to the right of the vertical center line, with the same vertical reading as the standard application.

These were applied for the purpose of determining the effect of changing their location toward the vertical center line of the back head and away from the knuckle, where the upward circulation of the water was believed to be greater than near the center.

An experimental water glass was also applied on the left side of the boiler, opposite the back flue sheet, the top connection of which entered the wrapper sheet on the top center line, 15 inches back from the throttle dome, while the bottom connection entered the wrapper sheet on the side. The lowest reading of this glass was 1 inch above the highest part of the crown sheet. This glass will hereafter be known as the "experimental water glass."

With this arrangement, observations were made during five additional trips, when the same conditions were found to exist that had been noted in the previous tests, with respect to the original gauge cocks, namely, full water showed at the top gauge cock, regardless of the level indicated by the water glasses, while the experimental gauge cocks indicated a level approaching that indicated by the water glasses while operating with open throttle or safety valves blowing.

While operating with throttle wide open and water glass three-fourths full, the bottom connections to both water glasses were frequently closed and drain valves opened, when dry steam would steadily flow through the experimental water glass and solid water would flow through the original water glass, which glass also showed the water in severe agitation while the locomotive was in operation. These experiments demonstrated that the level of water indicated by the gauge cocks and water glasses varied with their point of connection with the boiler, and indicated that a higher level of water prevailed at the back head than existed further ahead.

It is believed that the transverse "T" iron, which was applied to the back heads of these boilers, hindered the movement of water up the back head near the center, and consequently decreased the variation between the level of water indicated by the experimental gauge cocks and that registered by the water glasses.

As a result of these experiments, which were brought about by the large number of crown sheets being damaged and fusible plugs being melted, the gauge cocks and water glasses were moved toward the vertical center line of the boiler, which seems to have relieved the situation to a considerable extent.

It having been concluded that the false registration of the gauge cocks, when screwed directly in the boiler back head, and the agitation of the water in the water glass when top connection is made near the knuckle, were due to the rapid circulation of the water upward, carrying it a considerable distance above the level further ahead, a number of locomotives of the following description were equipped with water columns, as shown by Figure 1:

These locomotives were of the Santa Fe or 2-10-2 type, equipped with Schmidt superheaters, Street stokers, used bituminous coal for fuel, carried 180 pounds steam pressure, with firebox 132 inches long and 96 inches wide, with brick arch supported by four arch tubes and back head sloping 15 degrees from vertical.

The water column applied on these boilers, as illustrated by Figure 1, was 1¾ in. inside diameter and 16 in. long, applied in a vertical position on the back head, 18 in. to the right of the vertical center line. The top connection was through a copper pipe 1-1/16 in. inside diameter, entering the wrapper sheet 12½ in. in front of the back head knuckle and 14½ in. to the right of the top center line. The bottom connection was made of copper pipe of the same diameter, and entered the back head 16 in. to the right of the vertical center line and 28 in. below the back end of the crown sheet. Three standard gauge cocks with ⅜ in. openings were attached to the right side of this column, three inches apart. One water glass was also attached, having ¼ in. opening. The lowest reading of both water glass and gauge cocks was 4½ in. above the highest part of the crown sheet.

By this arrangement, it was believed that when entering the boiler far enough ahead of the back knuckle to obtain dry steam at all times through the top connection to the column, and by taking water from well below the crown sheet and below the agitated portion of water which was believed to exist near the back end of the crown sheet and back head, a more correct reading could be obtained than when the gauge cocks were screwed directly in the boiler head. During an ap-approximate six-month period, however, that these locomotives were operated with this arrangement, very considerable trouble was encountered, due to the extremely erratic and unreliable action of the water indications.

It was then determined that something should be done to learn just what caused the trouble. Therefore, one round trip was made, covering 240 miles, where observations were taken under actual operating conditions, with the following general conditions noted:

At first start there was 3½ in. of water in the glass.

Reverse lever in full forward motion, with engine working up to the slipping point and working considerable water through the cylinders for about two miles.

When locomotive was started the water in the glass receded very rapidly until it disappeared.

Left injector was started at once.

By opening any of the gauge cocks which had openings ⅜ in. in diameter, after the water had disappeared, dry steam was omitted for a few seconds, when the water in glass and column would rise to the cock that was opened and would be maintained unsteadily at the same level until the gauge cock was closed, when the water in the glass would instantly recede slightly below this cock, which would be two to five inches higher than the level indicated before the gauge cock was opened. From this point the water would gradually recede, taking four or five minutes to drop to the low point, and, when reached, the water would work normally in the glass, but would gradually recede to different levels and sometimes out of sight, depending upon the temperature of the water in the lower connection to the column.

This test was made many times during the trip and in all cases practically the same results were obtained.

When the drain cock to the water glass was opened, the water in the glass and column would be raised as a result, and, when closed, the same receding conditions prevailed as when the experiments were made with the gauge cocks, but would again settle to an indefinite point, sometimes out of sight, depending upon the temperature of the lower column connection.

The gauge cock was frequently opened slightly, so as to create a slight circulation through the column, which kept the temperature in the column and connection approximately that in the boiler, during which time the column glass and gauge cocks appeared to register correctly."

During these tests the temperature of the atmosphere was below zero, which caused the water in the column and in the long pipe by which the bottom connection was made to cool rapidly, which in turn caused the level of water in the column to lower. In order to demonstrate that this reduction in temperature was the cause of the receding action in the column, ice water was poured on the bottom of the column and connection, which caused the water in the column to lower very quickly while being cooled, and would rise as soon as circulation was again established in the column.

It was demonstrated by experiments that this lowering of water in the column was due to the volume of comparatively cool dead water contained in the long pipe through which the bottom connection to the column was made.

After noting these results and for the purpose of comparison, another water glass and set of three gauge cocks were applied in the usual manner, as illustrated by Figure 1, the water glass connections entered the back head at the left of column and the gauge cocks entered near the knuckle. The comparative readings of all gauge cocks and water glasses corresponded. For reference purposes the gauge cocks and water glass applied to the column will be referred to as No. 1, while those applied in the usual way will be referred to as No. 2.

With the indicating devices arranged as outlined, observations were made during three successive trips, or 720 miles, when the following general results were noted:

"Previous to starting, all devices indicated a corresponding level, but, when the throttle was opened or safety valves lifted, the water in No. 1 glass would recede approximately 2 inches while that in No. 2 glass would rise. No. 2 glass indicated a level of water from 1 to 3 inches higher than that indicated by No. 1 glass. In some cases, however, the water was out of sight at the bottom of No. 1 glass, while No. 2 glass indicated a level of from 3 to 5 inches."

After noting these results, the following change was made: The bottom connection to the water column was raised 28 inches and moved to the right 2½ in. This new connection was made midway between the two right arch tubes and approximately 10 in. above them, about in line with the back end of the crown sheet. The object of this change was to move the bottom connection up as close to the lower end of the column as possible, and to reduce the volumn of dead water in this connection in order to eliminate the lowering effect referred to. After this change had been made, the following general results were obtained: When starting, the level in both water glasses rose slightly and both glasses worked normally; and when throttle was closed, the level would recede slightly, the readings of both glasses corresponding under all conditions of service.

A comparison of the No. 1 gauge cocks with the No. 2 water glasss showed that they registered the same level when the gauge cocks were opened moderately, or a sufficient amount to obtain a correct reading, but by opening the No. 1 gauge cocks an excessive amount, or wide open, the water in the column and attached glass would rise from the bottom to the level of the cock opened. When the gauge cock was closed, the water would instantly recede to its original working level and correspond with that shown in No. 2 glass. The receding action, as noted in the previous tests and before the bottom connection was raised, was entirely absent and the water registered a corresponding level in both No. 1 and No. 2 glasses under all conditions of service.

Tests of the No. 2 gauge cocks, located as they were near the knuckle of the back head, proved that they were wholly unreliable for the purpose of registering the correct level of the water in the boiler while the locomotive was working, as they showed full water at all times, throughout the entire test, regardless of the level indicated by the water glases and No. 1 gauge cocks while steam was being rapidly discharged from the boiler, due, without question, to the rise of water up the back head. While standing, and with no steam escaping, the readings of both water glasses and all gauge cocks registered alike.

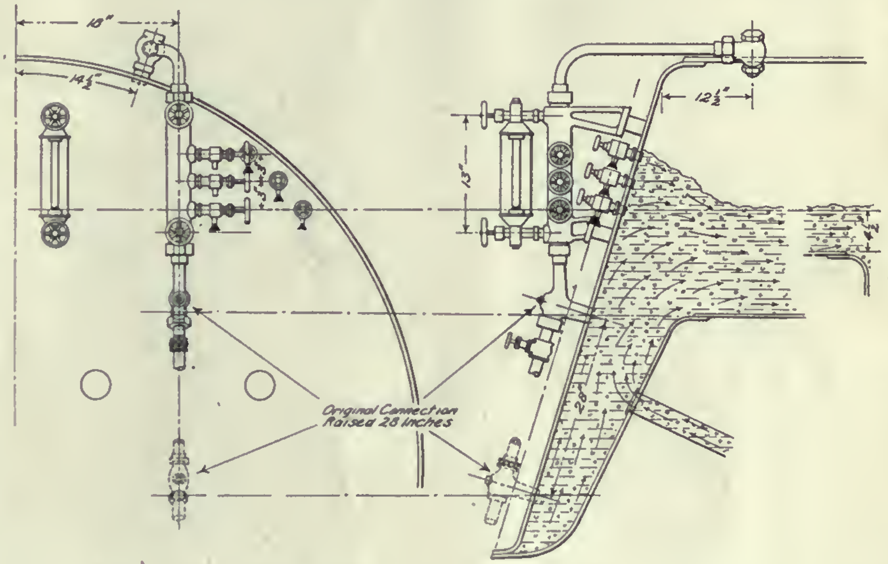

FIG. 1. WHEN THE CONNECTIONS WERE IN THE LOWER POSITION THE GAUGES WERE FOUND TO GIVE A FALSE READING BECAUSE OF THE LONG DISTANCE BETWEEN THE COLUMN AND THE BOTTOM CONNECTION TO THE BOILER.

Further observations and tests were made while on heavy grades, but no unusual or improper conditions could be noted except that No. 2 gauge cocks registered full at all times, as previously stated, and the water in the column glass could be raised to the height of the gauge cock opened, when opened excessively.

A third series of tests were then made with a heavy Mallet locomotive having a firebox 170⅛ in. long and 96¼ in. wide and carrying a steam pressure of 240 lbs.

The crown sheet was 15 ft. 7 in. in length, with firebox equipped with Gaines furnace, and brick arch extending to within 68 in. of the door sheet and within 22½ in. of the crown sheet, supported by five 3½ in. arch tubes, using bituminous coal for fuel and fired with Duplex stoker. The boiler was equipepd with one water column to which three gauge cocks and one water glass were attached. Two gauge cocks were applied directly in the back head and two water glasses applied in the usual manner, one on each side of the vertical center line of the back head as illustrated by Figures 2 and 3.

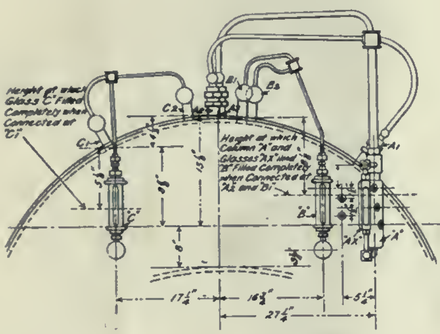

FIG. 2.

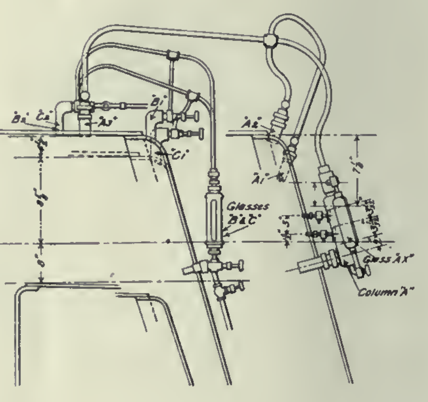

FIG. 3.

The lowest reading of the gauge cocks attached to the water column, and all water glasses, was 8 in. above the highest point of the crown sheet and 13⅛ in. below the top of boiler back head. The limited dry steam space at the back end of this boiler had a marked effect on the readings of these devices when connected in the back boiler head.

It will be readily understood that when water, from any cause, reaches the top connection, it destroys the proper registrations of these devices, and the idea in mind, when arranging the top connections in the manner illustrated, was to determine whether or not the reading of the water glasses and water column would be altered when changing from one connection to the other, which were in line with the upward flow of water between the door sheet and the back head, the object being to obtain dry steam to balance the volume of water in the water glasses and water column. The result of changing from one connection to the other was indeed surprising.

While the locomotive was standing, with no steam escaping, the registration of all devices showed a corresponding level of water. A total of 121 readings was taken and recorded while on straight track and while the locomotive was working with heavy throttle with about the same firebox temperature and steam pressure.

For reference purposes, the water glasses and water column, with their connections, are referred to by letters and figures as follows:

A—Water column to which three standard gauge cocks were applied.
Ax—Water glass applied to water column.
A1—Water column connection where it entered boiler on back head knuckle ½ inch higher than top gauge cock and 6⅝ inches below highest part of back head as originally applied.
A2—Water column connection where it entered boiler at highest point of back head knuckle.
A3—Water column connection where it entered boiler on top center line in front of back head.
B—Right water glass.
B1—Right water glass connection where it entered boiler in back head knuckle.
B2—Right water glass connection where it entered boiler in front of back head.
C—Left water glass.
C1—Left water glass connection where it entered back head knuckle 4½ inches below highest point of back head, measured vertically and 2⅛ inches above top water glass reading, as originally applied.
C2—Left water glass connection where it entered boiler in front of back head.

With the locomotive working heavy throttle, column A and glass Ax, connected at A1, the original connection, would be completely filled, while glass B, connected at B1, indicated 1 inch of water. By changing the connection A1 to A2, the water would instantly recede to a level in A and Ax corresponding with that indicated by glass B, or 1 inch, when A, Ax and B would continue to correspond while connected at A2 and B1, until the reading approached 4½ to 5 inches, at which point the water would become erratic and soon fill column A and glasses Ax and B if the injector was slightly over-supplying the boiler, or would recede and correspond if the water was slightly lowering in the boiler. This indicated that the water was moving up the back head, with fountain effect, to a point reaching the connections A2 and B1 where they entered the top knuckle of the back head, 8⅛ in. higher than they registered when connected at A3 and B2 on the wrapper sheet, and was illustrated by changing the connection to column A and glass B from A2 to A3, B1 to B2, when the water would instantly recede to its former reading, and the readings would then continue to correspond as long as the connections remained at A3 and B2, without regard to condition of service or height of water indicated.

These readings could be varied as often as desired, by shifting connections to the boiler by use of the valves; that is, when the column connection was changed from A3 to A2, the water would immediately go from 5 in. to out of sight in glass Ax, and top gauge cock would show full water; or, when changed from A2 to A3 the water would recede from out of sight to a level of 5 in. and correspond to the reading shown by glass B connected at B2.

With glass B connected at B1, the reading would correspond with column A and glass Ax when connected at A3, until the level approached 5 in., when the water in glass B would become erratic and soon fill the glass, while column A and glass Ax, connected at A3, retained their level of 5 in.

These experiments illustrated that column A and glass Ax were incorrect when connected at A1, the original connection, with 1 inch or more of water; and, when connected at A2, were incorrect when the level indicated exceeded 4½ to 5 in.; and correct at all times when connected at A3; and that glass B was correct when connected at B1, until the reading indicated 4½ to 5 in., and incorrect when more water was shown, until connection was changed to B2.

With glass B registering 5 in. of water, the connection was changed from B2 to B1, when the glass would immediately fill; and with the bottom water glass cock closed and drain valve open, solid water flowed steadily through the drain pipe, which showed conclusively that the flow of water up the back head, with fountain effect, reached the connection B1, where it entered the back head knuckle 8⅛ in. higher than the correct level of water in the boiler or that registered by glass B when connected at B2, and by A and Ax when connected at A3.

With glass C in communication with the boiler at C1, its original connection, it registered a level corresponding to that indicated by column A, glass Ax when connected at A3 and with glass B when connected at B2, until the water registered 2½ to 3 in., at which time the water in glass C would become erratic, rising and lowering and quickly fill completely, providing the injector was more than supplying the boiler, notwithstanding column A and glasses Ax and B, connected at A3 and B2, worked normally and indicated 2½ to 3 in. of water.

When glass C communication was changed from C1 to C2, the water would instantly recede from out of sight at top to a level of 2½ to 3 in. and give a corresponding reading with column A and glasses Ax and B, which was true at all times when all connections were made ahead of back knuckle, regardless of the condition of service or the level of water in the boiler.

The reading of glass C, when it indicated 3 inches or more of water, could be changed as frequently as it was desired, by changing the communications from C1 to C2 or vice versa.

It was noted on one occasion, with column A connected at A1, glass B connected at B2 and glass C connected at C1, the locomotive moved to a left hand curve, at which time water glass B registered 2 inches of water while column A and glasses Ax and C were completely filled.

Sixteen readings were taken on the fourth trip, with column A connected at A1, the original connection, glass B at B2 and glass C at C1, original connection, during which time glass B indicated a level of from 1¼ to 4¾ in., while glasses Ax and C and all gauge cocks in both column and back head showed full of water. In fact, the gauge cocks applied directly in the back head showed full of water at all times during these tests, while the locomotive was being operated or when the safety valves were open.

By referring to Figure 3, it will be noted that connections to water glasses are made to the boiler through ell connections. In changing the Street ells from their original location on the back head, to the location shown at B2 and C2, the C2 connection was tapped so as to drain thoroughly, while B2 was leaned sufficiently to cause a trap to be formed. This trap caused the water in B glass to rise 2 to 3 in. higher than that registered by the left glass; and when this trap was removed, the water indication in all three glasses corresponded. This condition has been found in a number of the locomotives under investigation, when, as soon as the traps were removed, the discrepancies were obviated.

For the purpose of determining if possible the general outline of the flow of water which evidently existed at the back head, when high evaporation was taking place, tests were made on one of the U. S. Railroad Administration Standardized 2-10-2 type locomotives, equipped with five arch tubes and brick arch extending to within 51 inches of the door sheet; fired with Duplex stoker and using bituminous coal for fuel. The test apparatus used in these tests is shown by Figures 4 and 5; the sliding tubes illustrated were graduated so that correct readings could be taken, and were made to pass through stuffing boxes so that they could be drawn in and out of the boiler and take water or steam from any desired point within reach.

During two round trips many readings were taken while the locomotive was in operation. It will be noted, by referring to Figures 4 and 5 that with 2 inches of water showing in all glasses and one gauge of water in the column, the gauge cocks applied on the left side of the boiler head in the usual manner indicated full water, while No. 1 tube indicated strong flutter at a 12-in. adjustment, No. 2 tube indicated a strong flutter at a 9¼-in. adjustment, and No. 3 tube showed an occasional flutter at the back head, showing a rise of water at the back head of approximately 9 in. above that being registered by the water glasses or existing further ahead over the crown sheet.

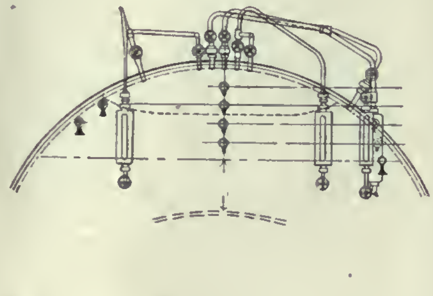

FIG. 4.

Dotted line indicates outline of water when 2 ins. registered in all water glasses when communicating with boiler at highest part of back head.

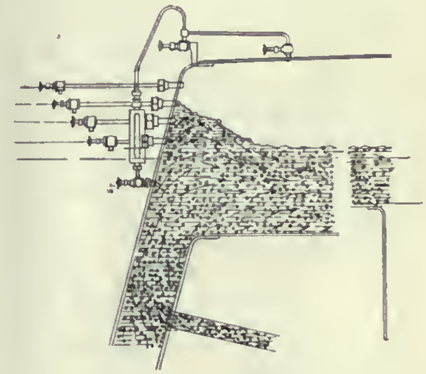

FIG. 5.

Side elevation showing outline of water while working heavy throttle with 2 ins. of water in glasses in communication with boiler at highest part of back head.

The dotted line in Figure 5 indicates what we believe to be the general outline assumed by the water where it reaches a greater height on each side than at the vertical center line of the boiler. It was found, during these tests, that with the top connection to the water column connected at its original position, the column would entirely fill when 4 or 5 in. of water was reached in the column glass. When changing from this connection to the highest point on the back head, the water would immeditely recede to 4 in., but when changing from one connection to the other on the highest part of the boiler, the readings were not affected, which indicated that dry steam was being obtained both at the back knuckle and further ahead, which was, no doubt, due to the increased dry steam space in the back end of this boiler and the exceedingly good water used for locomotive purposes in this district.

To further determine the approximate outline and proportions of the water conditions existing at the back boiler head, while the locomotive is being operated with heavy throttle, or when steam is being rapidly generated and simultaneously escaping from the boiler, tests were made with appliances shown by Figures 6 and 7, covering a distance of 808 miles, in bad water districts, on approximately level track and while handling regular tonnage.

The locomotive on which these tests were made was of the heavy 2-8-2 type, equipped with superheater and Duplex stoker, using bituminous coal for fuel. The boiler had a sloping back head, with firebox equipped with brick arch supported by four 3-in. arch tubes, the brick arch extending to within 52 in. of the door sheet and 30 in. of the crown sheet.

The apparatus shown by Figure 6 consisted of four gauge cocks applied directly in the back head near the knuckle, one water column to which three gauge cocks and one water glass were attached, one water glass with a 9-in. reading, standard application, with both top and bottom cocks entering boiler back head direct, one water glass applied for experimental purposes with the bottom cock entering the boiler head direct and with one top connection entering the boiler head on back knuckle and one entering 13 in. ahead of the back knuckle, and four exploration tubes or sliding gauge cocks.

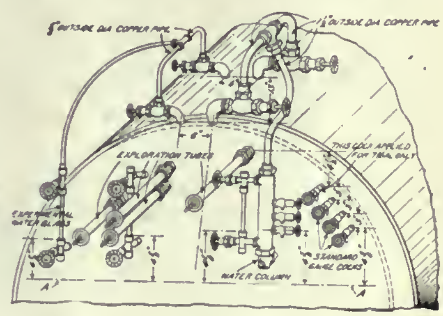

FIG. 6.

A—Highest point of crownsheet. Location and connections of equipment used to determine actual level of water throughout locomotive boiler as compared with height of water registered by water glasses and gauge cocks.

Figure 7 shows a side elevation of these exploration tubes or sliding gauge cocks entering the back head parallel to the horizontal axis of the boiler through suitable stuffing boxes, with a vertical pitch of 3½ in., giving a total vertical reading of 10½ in., whith a horizontal adjustment of 24 in. Gradations were marked on these tubes so that accurate readings could be taken and recorded. The lower one of these tubes entered the boiler head on a level with No. 2 gauge cock. The lowest reading of all water glasses and gauge cocks was 4⅝ in. above the highest point of the crown sheet.

It will be noted from this figure that while tube No. 1 was submerged, tube No. 2 showed a flutter of steam and water at an adjustment of 24 in., tube No. 3 showed water at an adjustment of 10 in. and steam at 13½ in., tube No. 4 showed water at an adjustment of 4½ in. and steam at 8 in. These readings were taken while the experimental water glass and water glass attached to the water column registered 2 in. of water, and the gauge cocks attached to the water column

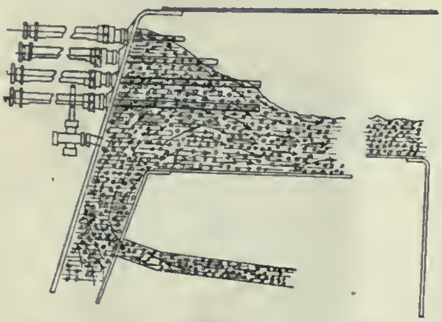

FIG. 7. WORKING VERY HEAVY THROTTLE.

Water in glass, 2 ins. Boiler Pressure, 160 lbs. Showing approximate outline of water at Boiler Back Head and elevation of tbis water above general level in boiler as indicated by Water Glasses and by Gauge Cocks applied in water column.

showed one gauge, while the four gauge cocks applied in the back head registered full.

The water in the territory where these tests were made is very light and foams badly when compound is not used. It is impossible to outline this flow of water accurately as it changes with the operating conditions and the condition of the water in the boiler, but it is believed that this serves to illustrate the general condition which prevails to a greater or less extent in all locomotive boilers, especially those equipped with brick arch and arch tubes, while the locomotive is working heavy.

It was found that approximately the same conditions were disclosed as those developed in other tests, except that the outline of water reached a higher elevation and greater proportions at the back head than those illustrated by Figure 5, which is, no doubt, due to the extremely good water used for locomotive purposes in the district where the previous tests were made.

The readings of the water column and experimental water glass, shown by Figure 7, could not be varied when changing from one connection to the other, as was the case in other tests, which we believe was due to the increased steam space in the back end of this boiler; and while the roll of water up the back head reached at times an approximate height of 12 to 13 in. above the general water level in the boiler, it did not apparently reach the top connection to these appliances in the back head knuckle.

When foaming very badly, there was a slight agitation in the experimental glass when connected in the back knuckle, and occasional bubbles in the glass, but not sufficient to attract serious attention. This agitation was entirely absent when the top connection was made ahead of the back knuckle. With 1 in. of water, or less, the water in the standard glass registered practically the same height as the other two glasses. With 2 to 2½ in. of water in the glass, when water was foaming, the water in the standard glass rose 2 to 3 in. higher, and there was much agitation and many bubbles in it, while the column glass and the experimental glass connected ahead showed no agitation whatever. With 3 in. or more of water in the standard glass and the water foaming badly, the standard glass would fill, and it was impossible to tell the actual height of water in the boiler by that device, without closing the throttle, while the experimental glass and the glass attached to the column continued to register 3 or more in. of water, and the top gauge cock, attached to the column, would indicate dry steam when opened in the usual way, and the four gauge cocks applied directly in the boiler would register full water.

For the sixth series of tests observations were made with a light in boiler.

Tests were made on a comparatively small locomotive, equipped with a wagon-top, radial-stayed boiler, having narrow OG firebox and vertical back head, the diameter of the largest course being 59 in. The special feature which should be borne in mind is that no arch or arch tubes were used in this boiler and that the back head was vertical.

The water-indicating devices consisted of three gauge cocks spaced 3 in. apart and applied directly in the right knuckle of the back boiler head, with a vertical reading of 6 in., and one reflex water glass with a clear reading of 7 in. and with top and bottom connections entering the boiler head direct on the vertical part 5 in. to the right of the center line. The lowest reading of the gauge cocks and water glass was 3 in. above the highest part of the crown sheet.

So that the action of the water could be observed, a glass tube was inserted in the top of the wrapper sheet which permitted the use of an electric light inside the boiler, which clearly illuminated the steam space over the crown sheet. Five bulls-eye sight glasses were applied over the back end of crown sheet, two over the front of crown sheet and three in the vertical back head so that the action of the water in this part of the boiler could be seen while under steam pressure. The arrangement of these appliances is illustrated by Figure 8.

Both main rods were disconnected, cross heads blocked at end of stroke and valve stems disconnected and so placed that steam was discharged through the exhaust nozzle and stack, creating a forced draft on the fire, representing as nearly operating conditions as possible.

When the throttle was closed and no steam escaping from the boiler, the surface of the water was approximately level, with a distinct circulation noted from back to front and from the sides toward the center of the crown sheet. When the safety valves lifted, the water rose with fountain effect, around the edges of the firebox, from 1 to 2 in., and

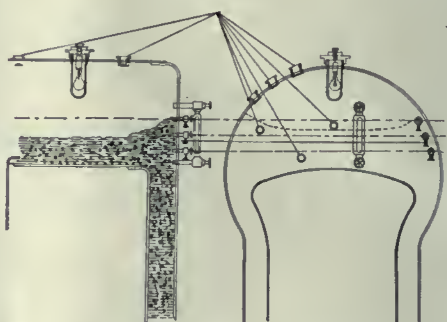

FIG. 8. SIDE ELEVATION.

Shows outline of water while water glasses registered a level of 2 ins. In cross sectional view dotted line indicates outline of water, while glass registered 2 ins.

the circulation was materially increased.

When the throttle was opened and steam was being generated and escaping from the boiler in greater volume, the level of water throughout the boiler was seen to rise 1 to 1½ in., which rise was registered by the water glass, and a marked flow of water, with fountain effect, was observed rising around the firebox at the back head and wrapper sheets, reaching a height above that over the remaining portion of the crown sheet of approximately 2 to 4 in. in proportion to the amount of steam being generated and simultaneously escaping from the boiler.

The important feature to be noted is that this height of water, as seen at the back head, was approximately 4 in. at its maximum, and was registered by the gauge cocks, while at the same time it could be seen that the water glass was registering the level further ahead over the crown sheet.

Among the interesting features observed were the size of the steam bubbles, which were approximately ¼ to ⅜-in. in diameter, and the rapidity with which they were seen to rise to the surface and explode. The size and number of these steam bubbles, which were seen rapidly rising next to the back head, explain one of the physical reasons for the increased height of water around the crown sheet and the rapid circulation attained.

These observations establish beyond question that when steam is being generated and escaping there is an upward movement of water at the back head of the locomotive boiler which carries it above that further ahead over the crown sheet, and that the gauge cocks, when applied directly in the boiler register this rise of water and do not indicate the level further ahead, while the water glass registers the level of water further ahead and not the fountain of water at the back head.

Since a difference of 4 in. was observed between the height of water at the back head and that further ahead in this boiler, there can be little question but that in the modern locomotive boiler, which has a sloping back head and is equipped with brick arch and arch tubes, which greatly accelerates the movement of water in this part of the boiler, due to the rapid circulation through the arch tubes and the deflection of heat against the door sheet and back end of crown sheet by the brick arch, this difference between the height of the water at the back head and further ahead over the crown sheet must be materially increased.

Figures 9 and 10 illustrate the circulation of water in the boiler. The feed water which enters near the front end is much lower in temperature than that in the boiler, which, due to its density and weight, naturally lowers and moves toward the firebox sheets where the greatest evaporation takes place. As the water is heated it rises, due to its decreased weight, influenced by the steam bubbles rising to the surface where they explode. This circulation causes a movement of water from front to back in the lower portion of the boiler, and upward around the firebox, and from back to front in the upper portion. This circulation unquestionably takes place with sufficient rapidity to carry the water in the boiler around the firebox sheets above the general water level, due to the limited space in the water legs, where the greatest amount of heat is applied.

Figure 9 illustrates a portion of a locomotive boiler equipped with brick arch and arch tubes where the general level of water in the boiler is 3 in. above the highest part of the crown sheet, the minimum required by law, and where the water glass, when properly applied in the usual manner, and the water glass and gauge cocks attached to a properly designed and applied water column, indicate the level of water over the crown sheet, while the gauge cocks in the back head register the water at the back head. This condition has been clearly established by the tests herein described.

Figure 10 illustrates the same portion of a locomotive boiler and a condition which may exist, where the water glass registration is ignored and the gauge cocks applied in the boiler are depended upon to register the correct level. Since practically all enginemen have been taught to rely on the gauge cocks in preference to the water glass, this is an especially unsafe condition, and is, no doubt, the cause of many damaged crown sheets.

It is recognized that the volume of water in the boiler increases in proportion to the amount of steam being generated and in the same ratio that the steam bubbles below the surface are formed and expanded, the volume of which depends to a very considerable extent upon the purity of the water in the boiler and its ability to readily release the steam being generated; consequently increasing the height of water in the same proportion, which height is registered by the water glass.

Since it has been established that gauge cocks screwed directly in the boiler do not correctly indicate the general water level, the question arises as to what would be a proper appliance. After careful investigation and tests, it is believed that Figure 11 illustrates a water column that will afford the safest and most practicable method yet disclosed for accurately indicating the general water level in the boiler under all conditions of service.

This arrangement has been recommended by the Bureau and was adopted as recommended practice by the Committee on Standards, of the U. S. Railroad Administration at its February, 1920, meeting. To this water column three gauge cocks and one water glass are shown attached, one water glass applied in the usual manner on the left side of boiler head for the purpose of forming a

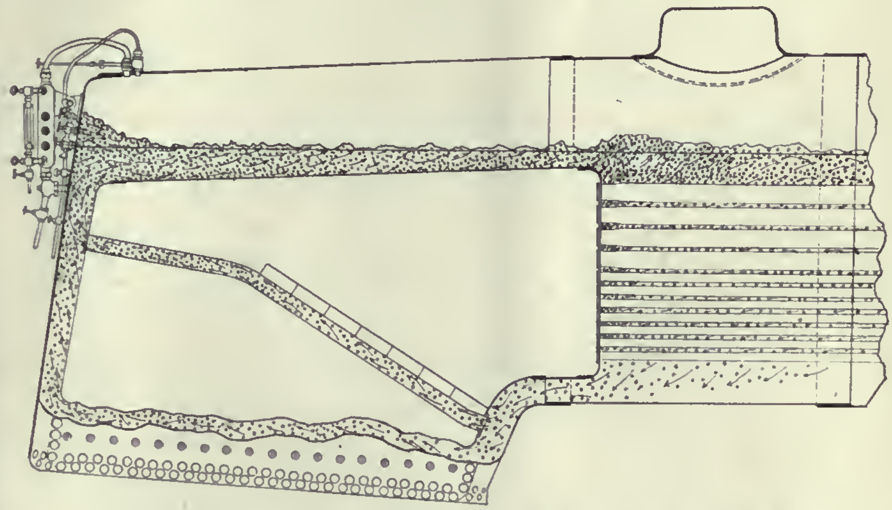

FIG. 9. ILLUSTRATING WATER CIRCULATION IN THE BOILER WITH ITS EFFECT ON THE WATER INDICATING DEVICES WITH 3 INS. OF WATER OVER THE CROWNSHEET.

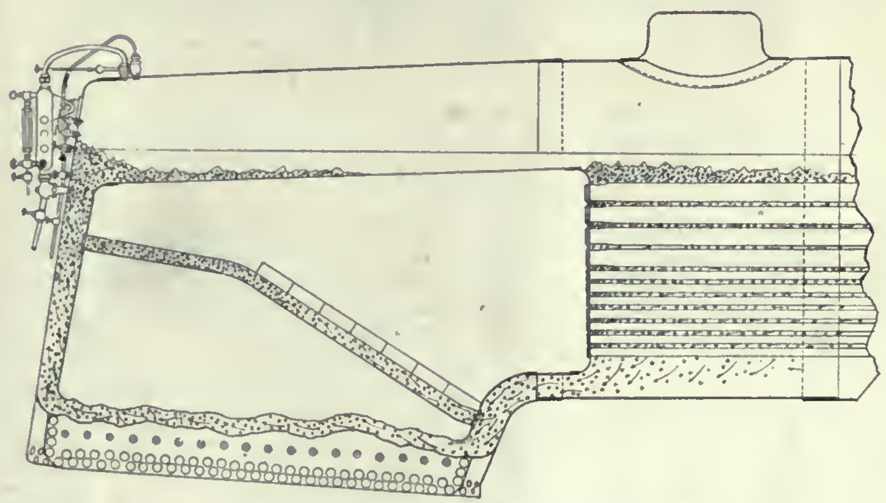

FIG. 10. ILLUSTRATES WATER CIRCULATION IN THE BOILER WITH THE EFFECT ON THE WATER INDICATING DEVICES WITH THE FRONT END OF THE CROWNSHEET UNPROTECTED.

double check of the height of water over the crown sheet and to broaden the view from different parts of the cab.

In constructing and applying the water column, the ratio of openings between top and bottom connections, as indicated by Figure 11, should be retained, and the bottom connection screwed into the boiler far enough to pass all obstructions which may be immediately above them. It was illustrated in the fifth series of tests that when the bottom connection to the column entered the boiler head one inch past flush, and directly under a "T" iron, it caused the water to rise one inch in the column glass, but when extended past the "T" iron, the readings in all glasses corresponded.

The larger connection to the top of the column, and restricted openings in the gauge cocks, which should be not more than ¼ in. in diameter, are suggested for the purpose of preventing the water from being raised when the gauge cock is op-

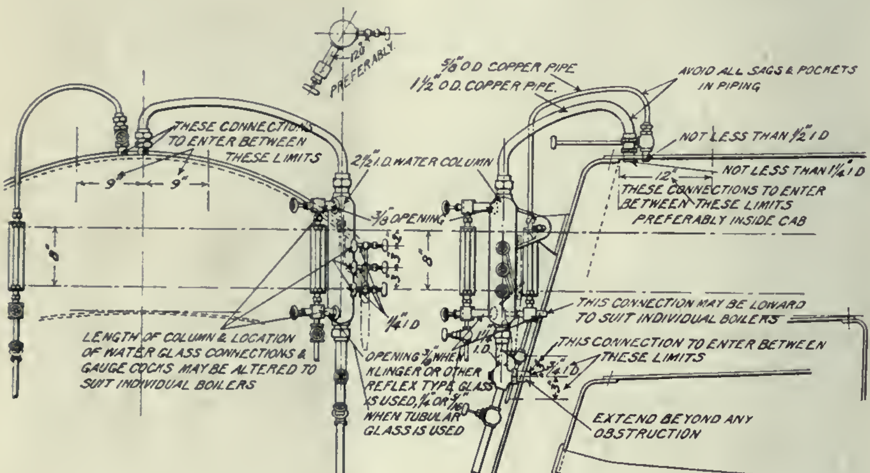

FIG. 11. RECOMMENDED PRACTICE ARRANGEMENT OF GAUGE COCKS AND WATER GLASSES.

ened wide, the object being to compensate for the lowering pressure in the column through the larger top connection, the area of the smallest opening of which should be not less than 1½ in. copper pipe, or preferably larger.

Very recent tests indicate that to avoid the possibility of inaccurate readings due to raising the water in the column when the gauge cocks are opened excessively wide, the inside diameter of the column may be made 3½ in. and that of the top connection 2 in. Experiments with column and steam pipe of these dimensions and the ¾ in. opening in the connection to the boiler at the bottom showed that the water in the column glass could not be raised, by opening the gauge cock, to exceed ¼ in., regardless of the amount or the length of time the gauge cocks were open.

It is recommended that the bottom water glass cock and bottom connection to the water column enter the boiler horizontally, and that the water column and water glasses should stand vertical.

Steam pipe connections to water columns and water glasses should be made as short as possible, so as to obtain a supply of dry steam at all times, and so arranged as to thoroughly drain, and be free from short bends or any possibility of sags or traps. It has been definitely established that where traps or sags that will retain the water of condensation are permitted in the top connection to water glasses or water columns, the reading of the water is materially affected, causing a higher level to be indicated.

It should be borne in mind that when water glasses are in proper condition to correctly register the water in the boiler, the water is never at rest while under pressure, and that when the water becomes slow or sluggish of movement or in agitation, it indicates an improper condition that should be immediately corrected. Such conditions are usually caused by restriction in the openings in the fixtures, sags or traps in the steam pipe connection, or the top connection made so as to allow water to enter and sometimes by bottom connection being improperly located so as to cause steam bubbles to enter.

The water-indicating appliances are among the most important devices on the locomotive, from the viewpoint of safety as well as economy; therefore, every effort should be made to see that they are so constructed, applied and maintained as to properly perform their function under all conditions of service, and so that the enginemen operating the locomotive may have the widest and easiest possible view from their usual and proper positions in the cab.

Speeding Up Car Repairs

The Commission on Car Service of the American Railway Association reports this month that at some large industrial centres, particularly steel centres, there are a large number of bad-order cars idle, where plants have been obliged to limit their operations owing to car shortage. It is suggested that, where possible, arrangements be made with these plants for repairing bad-order cars, and thus serve the double purpose of furnishing work for the plant which might otherwise shut down, and at the same time produce equipment in which to forward their shipments.

Where plants are not in a position to produce the necessary plates and forms for car repairs, the required material could be furnished, the plant performing the assembling and repair work. In the Middle West several roads are sending cars to shops outside of their territory which are in a position to make car repairs. Under existing circumstances and in view of the fact that every one per cent improvement in the bad-order car situation means an addition of about 25,000 cars to the available supply, the committee urges that every effort be made to reduce the percentage of cars in bad order to a maximum of four per cent.

It is also pointed out every hour saved by shippers or receivers of freight in loading or unloading the cars will enable them to get into action the more quickly.

Fuel Value of Wood.

Two pounds of dry wood of any non-resinous species have about the same heating value as a pound of good coal. A ton of coal may be taken as equivalent to one cord of heavy wood, one and a half cords of medium weight, or two cords of light wood. Resin gives twice as much heat as wood, weight for weight, hence pine fires have a much higher heating power than the non-resinous forms. The resin content is considered to be about 15 per cent. The fuel value of wood, however, depends upon several other properties besides calories, such as easy ignition, rapid burning and smokeless and uniform heat. As a rule soft wood burns more readily than hard, and lights more readily than heavy. Pines give quick hot fires, but oak gives a steady heat.

Douglas Fir Railway Ties.

It will be recalled that during the world war Douglas fir railroad ties were introduced on some of the eastern railroads in the United States, but were looked upon only as an emergency measure. Some experienced authorities were dubious as to the durability of this timber when used in the comparatively dry climate of the eastern states, but, thus far, experience is largely favorable to use for this purpose. In view of the high prices for other kinds of timber, the Douglas fir will likely come largely into use.

Electrical Department

Suggestions in Motor Maintenance—Cooling Railway Motors

Putting On Pinions

In the application of the electric motor to railway work gearing is used almost universally. It is true that motors are directly connected to machine tools, slotters, shapers, etc., but many find there is a gear reduction between the motor and the machine. For economy of operation and lower first cost, the motor chosen runs generally at a speed several times that of the machine shaft, so that a gear reduction of 1 to 4 or 1 to 5 is used. The gear is mounted on the machine shaft, or in the case of a railway motor driving a car or locomotive, the gear is mounted on the axle. It is an easy matter to put the gear on tight, as the diameter of the axle or shaft is of such size that the gear can be pressed on at several tons pressure, the pressure depending on the diameter of the fit.

In the case of the pinion the number of teeth are few so that the bore through the pinion is of small diameter. Again the pinion when put on comes very close to the end of the motor, so that generally the pinion fit is made a taper fit. The pinion can be put on easily up to the fit and then provision must be made to get the pinion tight. Many times a nut is provided and it is generally believed that if a pinion is shoved on the shaft and the nut tightened the pinion will run satisfactorily without loosening. A key is provided to serve as a means of a connection between the shaft and the pinion, but to obtain satisfactory operation the driving tongue or pressure should not be made through key, but through a real fit between the pinion and its shaft. The key should act merely as a safety device in case the pinion should loosen, and prevent the pinion from actually turning on the armature shaft. The pinions can be pressed on, but an easier and equally satisfactory method is to shrink them on.

When putting pinions on shafts having taper fits it is well to follow the suggestions made here, namely, that the shaft should be free from burrs or swellings: the pinion bore should be clean and free from burrs; the pinion bore fit should be in contact with at least 75% of the surface of the taper fit on the shaft.

It is well to try the pinion when cold on the shaft, to see that the key is of the proper size and does not bind and that the pinion will go on freely to the desired position when ready.

If the pinions are pressed on cold, about 12 to 25 tons will be required, depending on motor shaft diameter. Pinions with 3-inch bore should advance on the shaft approximately 1/32 inch, those with approximately 4-inch bore should advance 3/64 and those with approximate 5-inch bore to 1/16 inch, the distance being measured from the point where the pinion is seated firmly on the shaft before pressing.

Pinions can be shrunk on. Generally the practice has been to heat the pinions by a flame or furnace and this method is satisfactory providing the flame cannot touch the teeth and the temperature regulated to 100 deg. C. (212° Fahr.) for pinions up to 125 H. P. and 125° C. (257° Fahr.) for pinion larger than 125 H. P., as only 100° C. (212° F.) is required. A much safer method is to use boiling water, as with this arrangement it is impossible to overheat the pinion. They should stay in the water at least

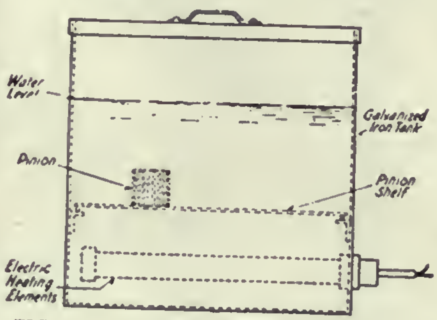

FIG. 1. ELECTRICALLY HEATED PINION HEATING TANK.

30 minutes and preferably 60 minutes until of a uniform pressure. Remove, wipe out bore and without allowing the pinion to cool, place on shaft and tap on with a light sledge hammer. The sledging is merely to make sure the pinion is home and well seated.

A heating tank built by the Westinghouse Electric Co., is shown by Fig. 1, where the water is heated by an electric heating element.

A gas flame or a steam coal can be used. Washing soda, in the proportion of ¼ lb. to 5 gals. of water, will prevent rusting.

Pinions put on after boiling in water will hold equally well with pinions pressed on at 12 to 25 tons and will stand the very hardest pulling from the motor.

COOLING RAILWAY MOTORS—PRECAUTION TO BE TAKEN WITH BLOWER INSTALLATION

The capacity of railway motors are increased by blowing air through them. The heat formed by the electricity flowing through the conductors is carried quickly away. The radiation, so to speak, is increased and more current can be passed through the motor, and hence more horsepower, without overheating the motor.

Railway motors today are in many cases self ventilated. A fan is mounted on the armature itself inside of the frame and the rotation of the armature draws air through the motor and cools it. The motor capacity is increased but not nearly as much as if an external blower is used and air is piped to the motors. A constant flow of air through the motors is obtained at all times even with motors standing still. Moreover, almost any amount of air, within limits of course, can be passed through the motors and much more than with the motor self ventilated. Therefore, the capacity of the motors can be still further increased over the self ventilated motor.

The large multiple unit cars, equipped with Westinghouse motors operating over the Pennsylvania R. R. out of the Broad St. station, Philadelphia, have blowers mounted on the under side of the body. In mounting the blower equipment a number of considerations should be kept in mind. The air must be led through ducts and the design of these ducts is important. The blowers must necessarily be mounted underneath and provision must be made to prevent dirt and moisture from entering the blower, as most of the dirt which is taken into the blower will reach the motors. Moisture in the form of rain or snow is more serious than dry dirt, as short circuits are liable to occur if the moisture continues to reach the motors. Light dry snow is the hardest to control.

To eliminate the dust and moisture the blower intake is arranged to take its air from an air box, with blowers placed underneath and at the side of the car. The air box should be equipped with baffles and, in winter, cheese cloth screens should be used to prevent the cold dry snow from being blown into the ducts. In fact the cloth screens prevents dirt also.

A baffle arrangement and louvers is shown by Fig. 2. A method used of screening the blower intake is shown by Fig. 3.

The cross-section of the main ducts should be such that the pressure loss is not increased beyond safe limits established by the required pressure at the motor. This can be understood from the following example:—With a layout to deliver 800 feet of air per minute to each of four motors with two motors on a truck, the main duct which has a cross-section of approximately one square foot running to each truck will be required to carry 1,600 feet per minute with a given

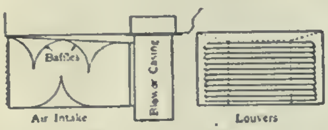

FIG. 2. CONSTRUCTION OF BLOWER INTAKE DUET AND LOUVERS.

pressure and a certain loss. Reducing the area to ½ square foot, the air will have to travel at twice the speed to deliver the same amount of air. The resistance of the duct will be approximately twice as great, requirng an increase in pressure to force the same amount of air through the duct. As the speed, and hence the pressure, of a railway blower unit is usually fixed, there will be a reduction in the total amount of air delivered to the motors. It is usually a

FIG. 3. METHOD OF SECRETING BLOWER INTAKE,

good plan to keep the area of the duct the same as the openings in the blower, or slightly larger where space permits. When arranging the duct opening for connecting the canvas bellows, care should be taken to have the opening of the duct directly over the motor opening, with the truck in the normal position, so as to give as little restriction to the passage of air as possible. In cases where the distance between the opening in the duct and the motor is short, a canvas tube may

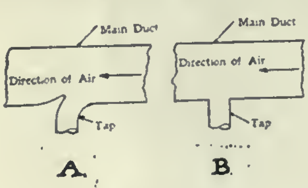

FIG. 4.

give better results than the specially constructed bellows.

Ducts can be made of any easily worked material, including wood, provided all joints are made air tight.

When it becomes necessary to make a number of consecutive taps in the main duct, it will be necessary to either reduce the size of the main duct after each tap or provide suitable baffles to deflect the air. If this precaution is not taken with a system using relatively high velocity pressures, the taps at end of main duct will take more than their share of the air. When making a tap from the main duct, construct as shown in Fig. 4-A and not as in Fig. 4-B.

Holland Commission Discusses Electrification with Westinghouse Engineers

For three days the commission of railway experts sent by the Government of Netherlands to this country to study American electrification methods, discussed with the engineers of the Westinghouse Electric and Manufacturing Company at East Pittsburgh questions which will involve the selection of equipment for Holland railways. The commission discussed the electrification of railways in general and in particular the Holland railway problems. It studied Westinghouse systems, both alternating current and direct current, and made a thorough inspection of the shops in which such locomotives were built.

The president of the commission is L. M. Barnet Lyon, member of the Board of Control of the Netherland Railways, and J. H. W. Van Loenen Martinet, chief of Electric Traction of the Netherland Railways, is secretary. The other members are H. J. Van Lessen, chief of Electrical Development of Holland; H. Doyer, consulting engineer, and W. J. Burgersdijh.

It is said that electrification will be started shortly on the railway connecting Amsterdam, the Hague and Rotterdam, which is about 50 miles in length. The equipment will be largely multiple unit. but some locomotives will be used.

Remedy for Car Shortage

Considerable interest is being manifested in a scheme put into operation by the railroads in Georgia and adopted by the Association of Railway Executives, that the average daily movement of freight cars be increased to 30 miles, as against 23.1 in 1919, and 24.6 in 1918. This increase which, it is stated, has been already accomplished in Georgia, if made possible on other roads would be equal to nearly half a million of extra cars. Surely this is an accomplishment devoutly to be wished and while it may not be as readily reached in some states as in Georgia, a united effort could not fail to produce good results.

Welding Cutters.

A cutter that is properly adjusted for its work must have the oxygen pressure, the orifice of the cutting jet and the flame correctly proportioned for the thickness of sheet to be cut. Generally, the pressure used is too high. Many operators seem to think that the work of cutting is a physical operation instead of merely a chemical process of destroying the metal. The use of these very high pressures is no doubt attributable in some measure to the high pressures to which the pressure gauges fitted to reducing valves are graduated. If the pressure used is too high, the speed of cutting is reduced owing to the cooling effect exerted by the expansion of the gas that is not actually used.

Chicago Section American Welding Society.

A new section of the American Welding Society was organized in Chicago last month. There were about seventy-five in attendance, representing nearly all of the railroads terminating in Chicago, and also many of the larger local industries. The officers elected are M. B. Osburn, chairman; C. T. Nelson, vice-chairman; L. B. Mackenzie, secretary-treasurer, 608 S. Dearborn street, Chicago. A Board of Directors was also elected, and meetings will be held on the second Tuesday of each month in the rooms of the Western Society of Engineers, and all interested in the subject of autogenous welding are invited to attend.

Steel Rails for Egypt.

It is learned that the Surveyor-General of Egypt invites tenders for the supply of cut rails in accordance with specifications and conditions available at Survey Office, Giza. Contractors are invited to put in their offers for any quantity available for immediate delivery or for delivery during the current financial year. Tenders should show quantity, weight per yard, rate per ton of 1,000 kilos, period required for delivery, place of delivery, and any other details necessary. Tenders must be presented on or before March 1, 1921. The London agent of the Egyptian Government has been communicated with in respect to this matter, and it is understood that the tenders from American firms will be accepted and given equal opportunity with those of British firms, provided deliveries, qualities, and specifications are satisfactory.

Brotherhood of Locomotive Engineers Establish a Bank

The Executive Department of the Brotherhood of Locomotive Engineers are taking action in regard to the establishment of a bank which will have commercial, savings and trust departments. It will be a commercial bank in form, but will be co-operative in its activities. The bank is to be a fraternal, co-operative organization. Its motive will be fraternal in spirit, looking towards building up the Brotherhood, and to aid its members in every possible way and to serve as a model to other organizations. We believe the organization of the bank will improve the power and status of the entire Brotherhood.

Pulverized Fuel in Australia.

Novel features have been introduced in mining and air-drying lignite, as well as in the process of pulverizing and burning the fuel, in Australia. The most striking improvement is what is known as the Buell system. Briefly described, the process is as follows: The lignite is mined in either shafts or open cuts, the coal being crushed on the spot to egg size, then hoisted to the air-drying tipples at the surface by bucket conveyors. After drying about seven days, the coal is relieved of practically half of its moisture content and is ready for final treatment. This final process, which should be undertaken near the place where the fuel is to be used, consists of again crushing the coal—to about ½-inch mesh—after which it is passed through a rotary drier, where the moisture content is reduced to about 10 per cent. The fuel is then pulverized, separated by air, and stored in bunkers.

To use it is blown through pipes, where it is mixed with air in quantity 10 per cent in excess of requirements and ignited at the tip of an adjustable burner, which enables the length and width of the flame zone to be most accurately gauged. Boiler tubes and baffles are kept clear of ash by soot blowers and suction conveyors carry off the ash to any desired place of disposal. Three per cent of the power generated is required to operate the plant, and one experienced man can fire a whole battery of boilers or kilns. Under test the boiler efficiency is claimed to be 80 per cent, and the furnace efficiency 78 per cent.

Rules of Interchange.

The following modifications in the Rules of Interchange have been approved by the Executive Committee of the American Railroad Association:

Effective March 1, 1920, all modifications of these rules having special application only to railroads under U. S. Federal control are cancelled, same being superseded by the General Rules.

Rule 3. The effective date of Section (d) of this rule has been extended to October 1, 1922, and the rule modified to read as follows:

> Cars built prior to October 1, 1915, will not be accepted in interchange after October 1, 1922, unless equipped with A. R. A. Standard axles.

The effective date of Section (i) of Rule No. 3 has been extended until October 1, 1922, and the rule modified to read as follows:

> After October 1, 1922, no cars with trucks of less than 60,000 lb. capacity will be accepted in interchange unless equipped with wooden or metal draft arms extending beyond body bloster, metal draft arms integral with body bolster, metal draft arms extending to body bolster and securely riveted to same, or transom draft gear.

Piece Work in Germany.

Recent advises report that a new system of piece work has been established in a government railway repair shop in Germany. The individual workmen are paid according to output as in all piece-work regulations, with an added incentive to profit sharing among the workmen. For example, a railway freight car,—according to standards calculated by the works manager, a delegate of the workers, and another official mutually chosen, —requires 500 hours for repair. The work may be performed in 408 hours, so that a saving of 92 hours is effected. Ninety-two, the number of hours saved, multiplied by 2.30 marks, gives 211.60 marks. The 180 per cent for expenses amounts to 380.88 marks; the sum of the two is 592.48 marks. Half of this sum, or 296.24 marks, goes to the gang of 10 workers employed on the job. The combined wages of these 10 workers for the job in question were 947.90 marks. The extra compensation of 296.24 marks paid to them for the saving in time amounts, therefore, to somewhat over 31 per cent. Newly employed workers are paid a share of the profits after 12 days' work with their gang. The standard number of hours fixed by the commission is not reduced when the worker receives higher wages. This system has already been in use in the workshops for four months. As a result production has increased 100 per cent. Another advantage is that the employment of supervisors has become unnecessary. Further, if any member of a gang shows a lazy disposition, the other members refuse to incur the loss of profit involved and demand his dismissal.

New Three-Cylinder Fast Freight Locomotive, North-Eastern Railway of England

A new class of 4-6-0- 3-cylinder fast goods locomotive has recently been designed by Sir Vincent Raven K. B. E. They have been built at the Darlington Works of the N. E. Railway Company.

The three cylinders, in one casting, are 18½ in. dia. by 26 in. stroke. The steam chests are common to all three cylinders, while the three exhaust chambers are separate to the bottom of the blast pipe. Bogie wheels are 3 ft. 1¼ in. dia. and eter. The total heating surface is 2,094 sq. ft., of which the firebox provides 166 sq. ft., the small tubes 866 sq. ft. and the super-heater elements and tubes 1,062 sq. ft., length of firebox, 9 ft. by 3 ft. 11 in. wide. Schmidt's super-heater is fitted.

Self-trimming tenders are used, having a capacity of 5½ tons of coal and 4,125 gallons of water. In working order the engine weighs 77 tons 14 cwt., of which 58 tons 14 cwt. are available for adhesion.

THREE-CYLINDER PACIFIC FREIGHT LOCOMOTIVE ON THE NORTH EASTERN RAILWAY—ENGLAND.

coupled wheels 5 ft. 8 in. dia. spread over a wheel base of 13 ft. 6 in.

The working pressure of the boiler is 180 lb. per sq. in., and at 85 per cent of the boiler pressure the maximum traction force works out at 30,032 lb. Diameter of boiler barrel, 5 ft. 6 in.; length, 16 ft. 2⅝ in. between tube plates. It is equipped with 102 tubes 2 in. diameter and 24 superheater tubes, 5¼ in. diameter. The tender in working order weighs 46 tons 2 cwt. Total weight of engine and tender is therefore 123 tons 16 cwt. Total length of engine and tender over buffers is 62 ft. 6 in.

The design is well proportioned and the engines present a neat and symmetrical appearance, and we understand are giving entire satisfaction in service on fast goods trains.

Items of Personal Interest

D. Johnson has been appointed general foreman of the Erie at Marion, Ohio, succeeding R. M. Wilson, transferred.

H. Schmidt has been appointed roundhouse foreman of the Erie at Cleveland, Ohio, succeeding F. C. Hunter, transferred.

B. C. Nicholson has been appointed shop superintendent of the Missouri, Kansas & Texas, at Denison, Tex., succeeding A. J. Lewis.

S. J. Dillon, general foreman of the Pennsylvania shops at Atlantic City, N. J., has been appointed shop inspector of the New Jersey division.

C. L. Bunch has been appointed master mechanic of the Southern, with headquarters at Meridian, Miss., succeeding H. M. Little, resigned.

H. E. Dyke has been appointed master mechanic of the Southern, with headquarters at Sheffield, Ala., succeeding C. L. Bunch.

C. G. Henderson has been appointed general foreman of the Southern, with headquarters at Chattanooga, Tenn., succeeding H. F. Dyke, promoted.

F. A. Linderman has been named division superintendent of motive power at Oswego, N. Y., instead of district superintendent of motive power, as formerly.

J. E. Stone has been appointed assistant master mechanic of the Southern Pacific, with headquarters at Sparks, Nev., succeeding Paul Jones, resigned.

J. B. Fraser has been appointed shop foreman of the Canadian National Railways with office at Saskatoon, Sask., succeeding A. D. McMillan, resigned.

Zilas Swight has been appointed mechanical superintendent of the Northern Pacific, Lines East of Paradise, Mont., with headquarters at St. Paul, Minn.

R. M. Crosby has been appointed mechanical superintendent of the Northern Pacific, Lines West of Paradise, with headquarters at Tacoma, Wash.

W. J. Bohan has been appointed assistant general mechanical superintendent of the Northern Pacific, with headquarters at St. Paul, Minn.

Enoch Hewitt, general foreman of the Pennsylvania at Meadows, N. J., has been appointed enginehouse foreman at Atlantic City, N. J., succeeding S. J. Dillon.

J. C. La Port, enginehouse foreman of the Pennsylvania at Coalport, has been appointed general foreman of the Meadows shops, N. J., succeeding Enoch Hewitt.

S. Watson has been named division superintendent of motive power of the New York Central, at Aves, Pa., in place of district superintendent of motive power as formerly.

A. J. Fries, assistant superintendent of motive power of the New York Central, second district, has been named to the position of superintendent of motive power.

C. F. Parsons, master mechanic on the New York Central at West Albany, N. Y., has been appointed general master mechanic, first district, with headquarters at Albany, N. Y.

J. W. Chandler, district foreman on the Poteau Valley line of the Kansas City Southern, has been promoted master mechanic with headquarters at Shreveport, La., succeeding A. B. Williams.

B. F. Shone, general foreman of the locomotive department of the New York Central at Depew, N. Y., has been appointed superintendent of shops at that point, succeeding J. G. Parsons.

C. M. Jacobson, shop superintendent of the Seaboard Air Line, with headquarters at Jacksonville, Fla., has been transferred to Portsmouth, Va., succeeding B. E. Greenwood.

F. W. Knott, master mechanic of the Alabama division of the Seaboard Air Line, with headquarters at Savannah, Ga., has been appointed shop superintendent, succeeding C. M. Jacobson.

J. B. Braun, master mechanic of the East Carolina division of the Seaboard Air Line, with headquarters at Andrews, S. C., has been transferred to Savannah, Ga., succeeding F. W. Knott.

H. McLenden, general locomotive foreman on the Seaboard Air Line, with headquarters at Savannah, Ga., has been appointed master mechanic at Andrews, S. C., succeeding J. B. Braun.

D. W. Roberts, division storekeeper of the Union Pacific at Armstrong Station, Kansas City, Kans., has been appointed general storekeeper of the Pere Marquette, with headquarters at Detroit, Mich.

J. G. Parsons, superintendent of shops of the New York Central, at Depew, N. Y., has been appointed superintendent of shops at West Albany, N. Y., succeeding H. Wanamaker, promoted.

M. W. Hassett, master mechanic of the New York Central, with headquarters at East Buffalo, N. Y., has been appointed general master mechanic of the second district, with headquarters at Buffalo.

B. B. Milner purposes resigning as engineer of motion power and rolling stock of the New York Central, with headquarters at the Grand Central Terminal, New York City, to assume a similar position in Tokio, Japan.

L. K. Sillcox, assistant general superintendent of motive power of the Chicago, Milwaukee & St. Paul, has been appointed general superintendent of motive power, with headquarters at Chicago, succeeding R. R. Warnock.

J. F. Bjorkholm has been appointed assistant superintendent of motive power of the Chicago, Milwaukee & St. Paul, in charge of motive power east of Mobridge, S. D., with headquarters at Milwaukee, Wis.

George T. Brown has been appointed master mechanic of the Fernwood & Gulf, at Fernwood, Miss., succeeding W. Spicer, who has been appointed master mechanic of the Williams Lumber Company, Ponchatoula, La.

J. F. Rosenbalm, general foreman of bridges, buildings and water service on the eastern division of the St. Louis-San Francisco, with headquarters at Springfield, Mo., has been transferred to a similar position on the same road, with headquarters at Fort Worth, Tex.

L. F. Burns, district supervisor of fuel economy of the New York Central, with headquarters at Rochester, N. Y., has been appointed master mechanic of the Syracuse division, with headquarters at East Buffalo, N. Y., succeeding M. W. Hassett, promoted.

W. P. Davis, master mechanic of the Harlem division of the New York Central, with headquarters at Brewster, N. Y., has been appointed master mechanic of the Mohawk division, with headquarters at West Albany, N. Y., succeeding C. F. Parsons, promoted.

A. T. Heintz, master mechanic of the Harlem division of the New York Central, with headquarters at Brewster, N. Y., has been appointed master mechanic of the Harlem division, with headquarters at Brewster, N. Y., succeeding W. P. Davis, promoted.

Harry R. Warnock, general superintendent of motive power of the Chicago, Milwaukee & St. Paul since 1917, has accepted the position of vice-president of the Standard Stoker Company, New York, in charge of the mechanical department with headquarters at New York.

W. B. Curtiss has been appointed assistant to George D. Emmons, vice-president of the General Electric Company, and will assist Mr. Emmons in charge of production in the company's factories, including the extensive plant in Schenectady, N. Y.

Lesley C. Paul, who has been occupied for several years on the editorial staff of the *Electric Railway Journal,* is now associated with the publicity department of the Westinghouse Electric and Manufacturing Company as technical editor in charge of matters relating to railway publicity.

W. J. Hughes has been appointed master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., succeeding E. W. Hopp, transferred to Aberdeen, S. D., who succeeds G. Lamberg, appointed shop superintendent at Minneapolis, Minn.

C. H. Hogan, district superintendent of motive power, first district of the New York Central, with headquarters at Albany, N. Y., has been promoted to manager, department of shop labor, with headquarters at Buffalo, N. Y., and H. Wanamaker, superintendent of shops at West Albany, N. Y., has been appointed to succeed Mr. Hogan.

H. M. Curry, mechanical superintendent of the Northern Pacific, has been appointed general mechanical superintendent, with headquarters at St. Paul, Minn. Mr. Curry entered the mechanical department of the Northern Pacific in 1880, and has held almost every position in the mechanical department during his uninterrupted forty years of service on the road.

George R. Van Namee, of the New York State Public Service Commission, Charles R. Vanneman, chief, and James J. Gill, inspector of equipment, Division of Steam Railroads, and W. U. Elliott, signal engineer, U. S. Balliet, signal engineer, electric zone, and T. L. Burton, air brake expert, of the New York Central, have been appointed a special commission to make an experimental installation of some automatic device looking towards the adoption of better methods of avoiding collisions and derailments. A portion of the railroad is being reserved for the special experiments.

John F. Long, district maintenance of equipment inspector of the Baltimore & Ohio, has been made division master mechanic of that part of the eastern district known as the Connellsville division. He succeeds H. J. Burkley, who is assigned to other duties.

Captain Long, late of the United States Engineers, served in France during the late war in the capacity of inspector of equipment at Santes, France; master mechanic of the Paris and Mediterranean Railroad at Nimes Garde, France, and master mechanic at San Sulpice Izan, France. Was commander of 395th Casual Company—Company N of 35th Engineers, and T. C. Company 103. Served the St. Louis and San Francisco as machinist, assistant foreman, division foreman, general foreman, master mechanic and shop superintendent, and was eight months with the United States Railway Administration as assistant supervisor of equipment.

M. E. Hamilton has been appointed as field engineer of the Automatic Straight Air Brake Company. Mr. Hamilton has had a wide experience in the mechanical department of several of the leading western railroads, and was for a number of years general air brake instructor on the Sante Fe, and also in a similar position on the St. Louis-San Francisco. Latterly Mr. Hamilton was engaged as field inspector of the Bureau of Safety, Interstate Commerce Commission.

M. E. HAMILTON

OBITUARY.

Melvin O. Adams.

The death is announced on August 9, of Melvin O. Adams, president of the Boston, Revere Beach & Lynn railroad for the past thirty years. Mr. Adams was born in Ashburnham, Mass., in 1850, and graduated from Dartmouth College in 1871, and engaged in law practice for several years, entering railroad service as director and general counsel of the road to which he was shortly afterwards elected president.

Arthur Patriarche.

Arthur Patriarche, formerly vice-president of the Pere Marquette, died on August 16, at Detroit, Mich., in his 72nd year. Beginning his railroad career in 1872, he earned rapid promotion in the freight and passenger service. He was elected vice-president of the Pere Marquette in 1905 and resigned in 1912. He was a writer of recognized ability.

American Society of Mechanical Engineers.

The 1920 annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies' Building, 29 West 39th street, New York, on December 7-10, inclusive. The newly founded sections on management, power, fuels, machine shop and railroads will conduct sections to consider the vital problems in their respective fields of engineering activity.

Master Blacksmiths' Convention

The International Railroad Master Blacksmiths' Association held its annual convention at Detroit, Mich., August 17-19 inclusive. A membership of 245 was reported. The question of amalgamating with Section III Mechanical was laid over pending necessary negotiations, and it is expected that decisive action will be taken on the subject at the next annual convention. The election of officers resulted as follows: President, Joseph Grine, New York; first vice-president, George Hutton, New York; second vice-president, S. Lewis, Canadian National; secretary-treasurer, W. J. Mayer, Michigan-Central. Montreal, Que., was selected as the place where the next annual convention will be held.

International Railway General Foremen's Association.

The annual convention of the International Railway General Foremen's Association will be held at the Hotel Sherman, Chicago, Ill., September 7-10, 1920. Details regarding subjects to be discussed and other matters of interest are being distributed in advance to the members by the secretary-treasurer, Wm. Hall, 1061 West Wabash avenue, Winona, Minn.

Wilson Welder & Metals Company.

The general offices of the Wilson Welder & Metals Company, are now located at 253 36th Street, Bush Terminal, Brooklyn, N. Y. The offices of the Wilson Welding Repair Company are now at 263 First Street, Jersey City, N. J. The offices of both companies were formerly at 2 Rector Street, New York City.

Domestic Exports from the United States by Countries, During June, 1920.

Steam Locomotives.

Countries	*Number*	*Dollars*
Belgium	49	2,653,500
France	61	858,000
Sweden	1	18,992
Canada	12	114,417
Honduras	5	14,056
Mexico	15	204,550
Newfoundland & Labrador.	1	19,290
Cuba	8	186,535
Dominican Republic	2	36,800
Colombia	4	56,442
British Guiana	1	22,700
Dutch East Indies	2	16,466
Australia	2	82,600
Total	163	4,284,348

Statistics of Railways.

The thirty-first annual report on the statistics of railways in the United States for the year ending December 31, 1917, prepared by the Bureau of Statistics has just been issued from the Government Printing Press, and extends to 530 pages. The report is compiled from the sworn returns made by owners and operators of steam railways used in interstate commerce. The separation of the carriers into classes based on their financial importance shows a growing improvement in the management of the matter in giving more complete details with respect to those carriers having operating expenses above one million dollars. The class of small carriers show fewer details because the reports made by many such carriers were too incomplete or otherwise too defective for extensive compilation. An improvement might be made in bringing the annual reports out at something nearer the present day, but large bodies move slowly.

Lubrication.

The lubrication of pneumatic tools is ably treated in the latest issue of *Lubrication*, issued by the Texas Company. It might not be generally known that oils used upon pneumatic tools should have a low cold test and greases to be successful must be manufactured from low cold test oils. In addition, pneumatic-tool lubricants should possess enough body to prevent metal contact and friction, but if they are too heavy for the mechanical conditions they tend to impede the action of the tools. "Viscosity" and the "Flow of Oil Through Pipes," are also articles of special interest in the same issue.

The Robinson Hose Connector

An illustrated booklet has been issued by the Robinson Connector Company, New York, furnishing details of the appliance, and also a view of the shop in which the device is manufactured. As is already well known the hose connector has been perfected and in service for several years, and there is every likelihood that it will now come into more general use. Copies of the booklet should be in the hands of all interested in the automatic coupling of hose, combining as it does the elements of safety and economy in train line connections.

The Commonwealther

The Commonwealth of May-June is portunity to remind us that many of the heavy de luxe passenger trains are drawn by locomotives equipped with Commonwealth cast steel one-piece tender frames and that they are practically indestructible, and because of their strength greatly lessens the possibility of accidents. Not only so but from the pilot to the back platform of the last car, Commonwealth steel devices contribute strength to the train and safety to the traveler.

Duplex Locomotive Stoker.

Type D Duplex Locomotive Stoker is fully described and illustrated in a booklet recently issued by the Locomotive Stoker Company, Pittsburgh, Pa. It is of the same size and binding as that usually employed in railroad instruction books, and copies may be had on application to the company's office, 50 Church street, New York.

Automatic Driving Box Wedge.

Bulletin No. 61, issued by the Franklin Railway Supply Company, New York, describes and illustrates the Driving Box Wedge which maintains correct automatic adjustment under all kinds and conditions of steam locomotive service. Full instructions are also furnished in regard to applying the important device to locomotives already in service.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXIII | 114 Liberty Street, New York, October, 1920 | No. 10

Reclamation Plant, Virginian Railroad

Large Savings Effected in Material

There is a reclamation plant of great promise in process of development on the Virginian Railroad at its Princeton, West Virginia, shops. It is said to be in the process of development because its possibilities and the plans for its future have not yet been fully realized. It is in charge of the material inspector of the road, Mr. F. S. Tinden, and though it has only been in operation for less than two years it is effecting very substantial saving in material.

At present the only building is little more than a shed and some of the tools and furnaces are in the open. There are two of these which are equipped for burning oil, and are intended for heating heavy pieces which will not stand cold straightening. The smaller of the two furnaces, shown in the illustration is used for heating the shanks of couplers that have been bent. The regular tonnage trains on the Virginian consist of 100 cars of 55 tons capacity each, and as these trains have to be taken down two grades of 1.5 per cent. of 6 and 12 miles in length, respectively, the stresses put upon the couplers during the cycling applications of the brakes, are often very severe, and considerable trouble is experienced in the bending of the coupler shanks. These bent couplers are put in the small furnace and raised to a bright red heat and then straightened at a small cost and returned to service.

Besides the straightening of the shanks, cracks in the bodies and knuckles of couplers are welded by the oxy-acetylene process and rendered as good as new.

The illustration shows two drawheads that had been cracked and afterwards prepared for welding. The regular method of cutting away the metal in the form of a V down to the bottom of the crack is followed and then the metal, thus removed, is replaced by building in the points where this has been done on the couplers of the illustration is indicated by an X. There are 1,500 of these reclaimed couplers in service and their breakage amounts to but two-thirds of one per cent.

Before starting to make the weld, the piece is pre-heated to a cherry red and then, when it is done, they are reheated and annealed.

The couplers come in in large quantities and are stored on a platform near the plant until taken in to be repaired.

The straightening of bent and distorted material is done under a homemade press shown in the illustration. It consists of a bed-plate and two uprights, A.A. carrying a crosspiece, B. which serves as a base for the attachments of the fulcrums D.D. The operating power is obtained from two air cylinders G.G. attached to the uprights on either side. These cylinders are each made of two 14 in. by 12 in. air brake cylinders bolted end to end. The pistons work upward against the connecting rods F.F. and operate the working levers C.C. which are pivoted to the fulcrum bars D.D. The short end of the levers are attached to the plunger E. and the two arms of the levers are so proportioned that with a pressure of 50 lbs. per sq. in. of air in

HEATING FURNACES, VIRGINIAN RAILROAD RECLAMATION PLANT.

CRACKED DRAWBARS PREPARED FOR WELDING, VIRGINIAN RAILROAD.

DAMAGED COUPLERS AWAITING REPAIRS, RECLAMATION PLANT, VIRGINIAN RAILROAD.

the cylinders a pressure of about 50,000 lbs. is obtained on the plunger.

This press is used for straightening the coupler shanks already referred to, and other heavy bars and material. It is also equipped with a traveling hoist the runway of which is shown at H. in the engraving.

The character of some of the miscellaneous material reclaimed is shown in the illustration of the plant. In this I. is the shed; K. the straightening press and L. one of the heating furnaces already alluded to.

The welding by oxy-acetylene is one of the chief money saving industries of the plant. In addition to the couplers of which there are about 2,000 on hand to be repaired, and of which also the road uses about 200 a month, a great deal of miscellaneous work is done. Some of this effects a very great saving. One of the greatest items of saving is that of repairing locomotive cylinders, where the cost of welding runs from $35 to $75 while that of a new cylinder would be nearly if not quite $1100.00. At one time there were thirteen of these cylinders on hand to be welded. One of the greatest reclamation savings made was that of repairing a winding drum for the Sewall's Point coal pier, whereon the cost of welding was about $100, while that of a new drum would have been about $4,500.

The only manufactured machine in the department is a set of straightening rolls with which the pressed steel parts of cars that have been damaged are straightened.

In addition to the reclamation of comparatively uninjured material the department makes up nearly all the brake-hangers used on the road from scrap. This work is done on a homemade machine which is made from an old brake cylinder. This machine consists of a plunger working between two rollers and driven by the piston in the cylinder.

A pile of these brake-hangers are shown in the foreground of the illustration of reclaimed material.

It is estimated that the savings effected by the department since January 1, 1919 is more than $50,000 above all operating expenses.

Adaptability of Electric and Oxy-Acetylene Welding.

Eminent authorities claim that it is generally admitted that the electric arc produces a higher temperature than the oxy-acetylene flame best suited for welding, the temperature of which is about 6,000 deg. Fahr. The higher and more concentrated temperature of the electric arc makes it possible to more rapidly reduce the metal to be welded to a molten state and, consequently, there is less time for heat to be carried away through conductivity of the metal before the weld is ef-

PRESS FOR STRAIGHTENING BENT AND DISTORTED MATERIAL, RECLAMATION PLANT, VIRGINIAN RAILROAD.

MATERIAL TO BE RECLAIMED AND GENERAL VIEW OF RECLAMATION PLANT, VIRGINIAN RAILROAD.

fected. The temperature of both the electric arc and the oxy-acetylene flames is, however, so greatly in excess of that required to fuse even iron or mild steel plates—the melting point of which is about 2,730 deg. Fahr.—that the increased speed of welding claimed on this account for the electric arc is only apparent when relatively thick plates are dealt with. A great many results of comparative tests have recently been published, but it is not easy to form any reliable conclusion from these, owing to the variable conditions involved, coupled with the fact that these results are inevitably somewhat colored by a leaning towards one or other system on the part of the investigator. The general impression, however, which is conveyed by these tests and confirmed by personal experience, is that for speed of work and cost in welding straight or simple seams in iron or steel plates, the oxy-acetylene process is unrivalled up to a thickness of ⅛ inch. For thicknesses of ⅛ inch to ⅜ inch there is not much to choose between the two methods, and above ⅜ inch thickness of plate, conditions favor arc welding. It is important, however, to note in connection with arc welding, that to obtain the best results, the metal electrode must be maintained steadily within ⅛ inch to ¼ inch of the work after the arc has been struck according to the thickness involved. On the other hand, the oxy-acetylene flame can be adjusted within relatively wide limits; consequently, for inside corners and complicated welds, the latter process always has the advantage whatever thickness of work may be involved. This flexible characteristic of the oxy-acetylene blowpipe enables it frequently to be employed where metallic arc welding is impossible, and that is one of the reasons why blowpipes are usually to be found in the general equipment of an electric welding workshop. There are, however, other cogent reasons why no such workshop is complete without an oxy-acetylene welding outfit, and one of these is that except for heavy structures, the blowpipe is markedly superior to the metallic arc in cast-iron welding repairs. Cast-iron is peculiarly liable to internal strains due to local contraction after welding. To prevent, or at least distribute these strains, it is important always to preheat a considerable area of metal round the parts to be welded, to effect the weld gradually, dispersing heat on each side of the weld during the operation and subsequently to cool down very slowly. Whilst the oxy-acetylene blowpipe lends itself admirably to such treatment, the intensely local heat of the electric arc can only effect a weld which is apt to concentrate these strains and produce a joint liable to fracture on cooling down. In motor cylinders and other structures of thin section this effect of electric welding is so marked that the oxy-acetylene process is almost invariably employed for such repairs. For the welding of aluminum, copper, brass and bronze, electric welding is also unsuitable and the oxy-acetylene process is usually employed for such work.

PRESS FOR MAKING BRAKE HANGERS. RECLAMATION PLANT DEPARTMENT, VIRGINIAN RAILROAD.

Fuel Oil for French Railroads

The serious scarcity of coal on French railroads has caused the Paris, Lyons, and Mediterranean Railway Company to transform some of its motive power from coal to fuel oil consumption, which is about to be followed by the Chemin de Fer de l'Etat, or State-owned Railway, and engines at its shop at Saintes are now undergoing changes for experimental purposes. Much attention is being directed to the announcement that the first-named railway company is planning to equip 200 locomotives for fuel oil.

RECLAIMED MATERIAL, RECLAMATION PLANT, VIRGINIAN RAILROAD.

Sixteenth Annual Convention of the International Railway General Foremen's Association

Addresses—Reports of Committees—Election of Officers

The annual convention of the International Railway General Foremen's Association was held at Chicago on Sept. 7-10, inclusive, President Wm. F. Gale, Chicago & Northwestern, presiding. An address of welcome to the delegates and visitors was made by Robert Quayle, general superintendent of motive power and machinery of the Chicago & Northwestern, wherein he laid particular stress on the importance of the duties entrusted to the general foremen in railroad repair shops, and pointed out the fact that largely by reason of the skill of American mechanics the railroads were enabled to move the ever-growing amount of freight cheaper than can be done in any other country in the world. In regard to the vexing question of unrest among the industrial classes generally, Mr. Quayle expressed his sincere pleasure at the feeling of almost complete unanimity of hopefulness that the railway men generally, and the shopmen particularly, were satisfied with the recent increase of wages, and he fell confident that a reflex of old-time activity would be manifested, and the shop foremen would be expected to see that pre-war conditions would be re-established, if they were not already in full operation.

The President's Address.

In the course of an earnest opening address, President Gale emphasized the necessity of an earnest effort on the part of everyone of increasing the production and means of conveyance, to the end that the markets of the world might be supplied with the abundance of America's products, and thus at once serve the country in providing the best transportation. In regard to the special work in which they were engaged, Mr. Gale claimed that shop foremen can get the best results by dealing kindly but firmly with the men under their charge. A spirit of self-importance begets ill-will. A spirit of fairness begets respect. The interest of their employers can best be served by properly understanding the details of the work in which they were engaged, and also by endeavoring to secure the hearty cooperation of all employes who may be placed under their supervision. The proper handling of labor was a subject that should at all times secure the fullest consideration.

Standardization of Engine Failures and Terminal Delays.

The committee on the above subject, consisting of William Hall, chairman; J. R. Harrington, Missouri, Kansas & Texas; W. H. Westbrook, Grand Trunk; H. E. Ventner, Southern Pacific, and W. Mulcahy, Baltimore & Ohio, presented a report in which was shown how minutely they had canvassed the subject. At the beginning it was stated that mechanical officials at the division points secure from the engineers all information regarding the failures, which is also supplemented by the written statements of the engineer. If, in the opinion of the party receiving the statement from the engineers, occasion of the failure was due to improper handling of locomotives by any member of the crew, the superintendent is requested to have an investigation made by the road foreman. If engineers contend

WILLIAM F. GALE, PRESIDENT
International Railway General Foremen's Association, 1919-1920.

that the failure was due to the engine not doing the work, or if the work as reported was not properly performed at the terminal from which the engine was dispatched, the party in charge was responsible for seeing that all work is performed on engines prior to making their trips, and is required to make a statement of facts as to the work done as reported by the engineer. The inspector is required to inspect all engines, check off all needed work as developed by his examination, and check his inspection against the work report of the engineer, and is further required to know that this work was performed in a satisfactory manner before the engine left the terminal. All parties performing the work are questioned in regard to the manner in which the work was done, and a decision is then made by proper parties as to whether or not the work was satisfactorily completed.

In the event of the failure of the parts of a locomotive, the broken parts are collected and delivered to the mechanical engineer for him to pass his opinion as to whether the defect was of such a nature as to have been caused by a flaw in the metal, by overheating, lack of lubrication, etc. If caused by flaw, steps are taken at once to secure a statement from the terminals between which engine has been operating as to what may have been detected or observed by inspectors, or covered by the work reports of the engineers. If, in the opinion of the mechanical engineer, the nature of the defect was caused by improper construction or parts, he will furnish new designs.

In the event of a failure being due to a lack of steam, the quality of the coal is taken into consideration and a thorough inspection of the engine's front end, firebox and flues is made. If flues are unduly stopped up, it is plainly evident that the terminal from which engine is dispatched is at fault and corrective measures are taken with those responsible.

If failures are due to improper firing or to an engine being mishandled, corrective measures are taken through investigation by the road foreman of engines. The train dispatchers make four copies of each engine failure report. The superintendent sends one copy to the general superintendent, one to the assistant mechanical superintendent, one to road foreman of engines and retains one copy. As this report is checked against the engineer's report, the train dispatchers and conductors must, therefore, give correct information. If the road foreman of engines considers an engine failure unjustly charged, he will write to the superintendent, giving his reasons, and if upon investigation the superintendent finds an engine failure has been charged without cause, he will cancel same, using regular report blanks for that purpose, and will send copies to the general superintendent, principal assistant mechanical superintendent, and to the road foreman of engines.

Among other details furnished by the Committee's report was a statement by an official on one of the leading railroads as to what should not be considered as an engine failure as well as what might be so classified. In his opinion, a breakdown of less than five minutes should not be called a failure, or that where there is a failure of five minutes or more and the engineer picks up the time that has been lost in fixing up the engine to complete the trip, and arrives at the terminal with no loss of time. This should not be classed as failure, nor do I consider where an engine has been in excessive duty on the road and crews relieved and fire gets dirty so that they have to stop to clean the fire to get it in shape to complete the trip, that an engine failure has occurred, but rather a transportation failure due to holding the engine too long in service.

Again a man may frequently stop along the road when he notices a back end of the main rod heating, stopping, and easing up the keys, making a delay of probably five minutes and starting up with his train again and picking up the lost time. This is done to avoid failure, but in a great many cases, is classed as failure. Also at times the train crew will set the brakes from the caboose, pulling a drawbar out of the back of the tank of the engine or breaking the drawbar between the engine and the tank. This is also classed as a failure, but I do not consider that it should be. Again, at times, they strike an obstruction such as a coupler that has been left on the track, knocking ash pan sides off, and that is improperly classed as an engine failure.

What should be classed as a failure is where an engine falls down through leaky tubes when it is put in excessive service, losing time, or where any material breaks down, being defective in itself or in the workmanship, causing a delay to exceed five minutes, or, in fact, any defect that is due to the engine, either through defective workmanship or defective material in the construction of the engine and constituting a delay of five minutes, should be classed as a failure. We might have a failure due to a broken spring hanger or spring, caused by bad track, and this, while it is a failure, should not result in the crew being censured or criticized for same.

In the discussion that followed the presentation of the report many conflicting opinions were advanced, and a suggestion was adopted that the committee be continued in the good work that they had begun, and extend its canvassing with a view of assembling opinions from every available source, and submit a consensus of opinion that may be universally looked upon as a standard definition of what constitutes an engine failure.

The Best Method of Repairing Superheater Units

The committee on the repairing of superheating units embraced W. L. Jury, Santa Fe, chairman; J. E. Stone, Southern Pacific; J. Martin, Big Four; E. P. MacDonald, Southern Pacific, and C. L. Walters, Great Northern. The report consisted mainly in describing the methods and means adopted on some of the larger railroads. Referring to the general usage in vogue on the Santa Fe, it appears that when superheater units became worn at the front ends between the bend and ball points, the method of repairing such units is to first determine if they are worn to an extent that would make them a possible cause of failure, and, if not, a hydrostatic test of cold water up to 400 lbs. is applied. While under pressure, a machinist or inspector should hammer-test all parts which show corrosion, especially around the return bend. If the bends in the tubes can be cut off with acetylene next to the bend, and rethreaded and the new bends applied. The new style units should be cut off at the return bend with acetylene on an angle of 45 degrees, and then by the aid of two air cylinders, with the jaws facing each other, place the unit between the jaws; while in this position, heat the parts of unit to form the new end, to a cherry red, and then turn the air pressure on both cylinders, this will bring the ends of unit together, forming a bend which is then welded together, using plenty of material to reinforce them on the flat surface and on the end of bend. After this is done, then apply 400 pounds hydrostatic and hammer-test again.

To repair the front end, or ball joint end of units, they should be cut off back of the bend, say five to eight inches, with the acetylene torch and then belled out to half the thickness of the tube, and back one and five-eighths inches. To make the new end, the ball is forged in a forging machine by taking a piece of tubing and making a ball on each end. This is done by two operations of the forging machine. After being forged, they are taken to the turret lathe, and the ball joint is turned, and tube is cut to whatever length is desired, and the end is turned to fit the ball end of the tube. These new ends can be made fifty or one hundred at a time, machined, ready to apply, and can be distributed to roundhouses or other than main shops which will save considerable time in returning power to service. After the new end is ready, it can be welded by acetylene in a very few minutes. The 400 lbs. hydrostatic pressure should then be applied to test the unit. In keeping the pressure up to 400 lbs. while inspecting superheater units, a dependable pump is needed, the design or make being immaterial. After a unit is tested, the band should be applied and spot-welded on each side to keep the band from slipping. This need not be over three-eighths of an inch in diameter and one-eighth of an inch high.

To get the best results in reapplying superheater units to the header, the ball joints should be thoroughly cleaned and polished with emery cloth. The joint should then be tried with a standard gage, and if found to be out, should be ground with a mixture of oil and cut steel, using a soft metal grinding form and a small air motor. If the joints are badly damaged, they should be trued up with a milling cutter, machined to the proper contour. After the joint is milled off it should be ground with oil and cut steel. The joints on the header casting should be thoroughly inspected, and if found to be in need of being machined, a milling tool of opposite contour to the one used on the ball joint should be used, and then ground with oil and cut steel, using a form of the same shape as the milling tool. Careful inspection should be given the slots in the superheater header to see that they are free from sand or scale and have a square surface, and that the bolt heads are square, so that there will be no chance of the bolts slipping. Threads on the bolts should be carefully examined and if found to be elongated, they should not be used. The use of steel bolts with an estimated strength of not less than 74,000 pounds is recommended. After superheaters are applied, they should be tested to the steam pressure of the boiler and thoroughly inspected to see that all joints are tight.

On the Cleveland, Cincinnati, Chicago & St. Louis Ry., if leaks develop under the hydrostatic test, these leaks are thoroughly sand-blasted, removing all carbon and scale from the neighborhood of the leak, and the leak is repaired with the acetylene torch. The renewing of bands or unit supports is done either with large specially designed tongs to grip and hold the bands in place when being riveted together, or an air squeezing device that holds the bands or supports in place while riveting.

In addition to its main testing apparatus, the Buck Grave shops have a portable testing outfit that can be taken to places throughout the shop where units have been removed for testing and grinding only. In either case, the actual time taken for testing a unit is not over two minutes. In the heavy repair plant, located in the boiler shop, there is a forging machine with suitable dies for renewing the return bends, and a similar testing plant to the one mentioned above. Metal cutting saws for sawing off defective return bends are provided as are also a sand-blasting device for removing all foreign matter from the ends of the units, and a reaming device for reaming the ball ends of the units to the proper radius, preparing them for grinding.

Experience has shown on this road that it is not profitable to use bolts for holding units to the headers with a tensile strength less than 70,000 lbs. The method of inspecting these bolts for elongation is by gaging the thread. It is always found that elongation occurs in the portion of bolt that is threaded for clearance under the nut. This can be easily detected by gaging the part of thread that has been used and the part of the thread that has not been used.

The first superheater equipment on this road was applied in July, 1911, and the average life of units, therefore, cannot be stated as the units of this first application are still in service. The theory of scrapping units due to loss of weight is not favored. By the use of micrometer calipers it has been found that the deterioration of the unit is very uniform, there being scarcely any variation between the front end and back end of unit. The most common failures are right at the end of unit where it comes in contact with cinders, and also which is the point subjected to the greatest degree of heat. When renewing return bends only enough is cut off to renew the bend. It is not necessary to make any sacrifice in the length of tubing owing to the deteriorated condition of that part of the unit. It is a very important matter to see that damper is maintained in working condition; as a failure on the part of the damper causes the back end of units to warp badly. The ball joint of unit is ground with lead forms and No. 60 to No. 80 carborundum. The clamps, washers, and the top of the header that comes in contact with the bolt, are thoroughly cleaned from all scale or other deposits to insure a first class iron to iron contact when clamping unit into place.

In the discussion there followed a variety of opinions as to the best practices on maintaining the superheater equipment. In regard to leakage in the ball joints between the units and the header, much of the difficulty at this point has its origin in the faulty conditions that are allowed to exist in the flues. The superheater may not be rigidly supported, as a result of which vibrations occur throwing strains on the ball joint connections, thereby inducing leakage. Accumulation of cinders and honeycombing of the flues have a pernicious effect. Not only do these accumulations cut off much of the effective heating surface of the superheater appliance, but also wedge the units in such a way that they are not left either to contract or expand with the inevitable changes in temperature, the results of which are to induce leakage at the ball joints. The improper alignment of the header is not infrequently a source of trouble. Difficulties have also been traced to roughness inside the superheater flues due to lack of care in safe-ending. Also when the slots which receive the header bolts have not been carefully cleaned out, trouble has been known to result from the adjustment of parts after the engine has been put out in service. It is evident that practices vary with respect to the stoppage of leaks in the return bends. With many the use of the oxy-acetylene torch is the popular method of closing these leaks. Some roads do not favor this method, but resort instead to the practice of cutting off the bends and reassembling the elements and bends by the threading process. Mention was made of the necessity for exercising care in adjusting superheater dampers so that when engines stand idle the units will not be subjected to extreme heat which is recognized as a further condition productive of trouble.

Reducing the Cost of Repairs to Cars and Locomotives

A committee on the above subject, consisting of C. F. Bauman, Chicago & Northwestern, chairman; C. W. Adams, Michigan Central; U. T. Cromwell and F. L. Wysong, presented a lengthy report in which it was urged that thorough, well-trained men should be selected for supervisors, and that they should have well-developed executive ability. Those who are fortunate enough to get a good training in different departments or a wide experience in various shops are particularly fortunate and generally well adapted for a supervisory position. All members of the staff should coöperate in order to have an efficient and energetic shop organization. Weekly shop meetings were an excellent means of increasing the spirit of good feeling looking towards the general welfare of all. At these meetings the shop superintendent or general foreman gets more closely in touch with the organization and realizes more fully the condition of each of the departments by hearing the reports that are made at the meetings, and suggestions for improvements in methods and management should not only be approved of but should be promptly established.

In regard to roundhouse repairs, the first object should be to take care of the smaller repairs on locomotives, which, generally, will only take a short time to make and require little material, thereby avoiding the later inevitable necessity of larger repairs. A systematic method of making the smaller repairs promptly as soon as their need is observed, has the desirable effect of keeping the locomotives out of the general repair shop for a longer period of time. It is also an advantage to have inspection pits provided before the locomotives pass over the ash pits, thereby giving an opportunity to discover any defects and report such information to the roundhouse foreman so that the necessary preparation and material may be ready in advance.

With regard to the general repair shop, there should be a workable shop schedule for getting the work out at a fixed time based on experience with such facilities as are available in the shop. It is well known that production has been reduced since piecework has been abolished, and this is not as it should be. The shop scheduling system must be closely adhered to if piecework is expected to remain in quiescence.

The best new machines and better facilities should be obtained, if at all possible, but as this is not always possible, the best should be made of such appliances and facilities as are at hand. It is well known that there is much loss occasioned by the use of old machinery and methods than there is, perhaps, from any other cause. The same may be said of many of the old contrivances still at work in the car department. It should be borne in mind that jigs, chucks, dies, box tools for brass work, pneumatic clamps, gang tools, milling cutters, templates and expanding mandrels all tend to decrease the cost of general mechanical operations. Toward the same end power-driven valve-setting rollers, motor-driven valve bushing pulling bars, rings for grinding cylinder faces and cylinder heads with air motor attachment, motor-driven flue cutters and flue rollers, and chucks for grinding steam pipe rings and superheater units with motors are all, when properly handled, capable of greatly reducing the cost of general repair work.

It is also of decided advantage to avoid the unnecessary handling of work. For example, all side-rod work should be confined to one portion of the shop, with rod racks, drill press, power press and lathes in close proximity to one another in order to avoid the loss of time between the several necessary operations on the various machines. The driving box gang should have the power press, brass crucible for pouring hub liners, planer, boring mill lathe and shaper within a radius of ten or twelve feet, so that when a driving box enters that part of the shop, it does not require to be conveyed elsewhere until it is ready for application.

In the handling of material considerable economies could also be made, particularly in avoiding the service of high-paid, skilled mechanics using portions of their time in looking for and conveying material from store rooms. This work should be done by cheaper labor, and if the material is placed in a well regulated store department there should be no delay in furnishing the material promptly at small cost. The stripping of one locomotive to make repairs on another should be avoided wherever possible. In many instances it means doing the same job twice when by a thoughtful ordering of material in advance such contingencies would be avoided. This is a proper subject for discussion at the meetings already referred to, and the shortcomings, if any, should cease.

The high quality of the work should also at all times be maintained. Slighting work because it may so happen that the engine is in a hurry is merely putting off the job until a more convenient season when more time will be spent than if the job had been thoroughly done when it was first attempted. When cars and engines are placed in the shops all parts should be carefully inspected and the necessary repairs should be made in the best possible manner. This will avoid much of running repair work which is usually more expensive because of the limited appliances in roundhouses. Especial care should be taken to note that car and tender wheels are properly centered, and the wheel gauge fits properly, at least at three equally distant points on the circumference, and that wheels of the same sizes are paired. This will help to prevent flange wear, and reduce the number of heated boxes.

The electric welding process is also a means of accomplishing much saving. Parts of the locomotive subject to rapid wear, such as guide bars, brake beam ends, brake hanger pins, radius bar ends, fork ends of eccentric rods that have become too wide for the links, driving boxes that have been worn down on the shoe and wedge faces, are now being built up by the use of the electric arc and are in many cases as good as new. In the boiler department particularly, the use of the oxy-acetylene torch is being used with great advantage in the welding of flues, flue sheets, side sheets and patches, rapidly superseding the older methods, with much saving both in time and material.

Mileage has also been increased and repairs lessened by giving attention to the best means in the matter of lubrication. The lubricating devices should be kept in good condition and a sufficient amount of lubricating oils should be furnished to meet the requirements. Graphite grease has proved itself in effecting great savings on the wear of engine truck and trailer boxes as well as on the end play of driving boxes. Men should be carefully trained to look after the proper packing and lubrication of journal bearings, and a supervision of their work should not be neglected.

In car work it has been found that the timbers and gears on wooden cars are the source of high cost of maintenance. Steel center sills, to which the draft gear is attached, almost entirely eliminate the maintenance of draft timbers and draft rigging, as it gives a substantial attachment to pull the train and also furnishes a buffing member which will prevent buckling of cars and in the case of box cars, the breaking of side plates over side doors. Pressed steel ends on box cars also prevents the breaking out of the ends. The ends may be readily reinforced by structural shapes which can be anchored to the side framing or floor framing and in some instances to the roof framing. As in moving appliances, a constant inspection should be made to avoid rapid deterioration which inevitably occurs unless repairs are promptly made.

In closing the report the committee laid special stress on the absolute need of the engines and cars being kept clean, as well as the shops and premises. Tracks adapted for 10 or 12 cars were also recommended, affording better facilities for the lighter repairs or removal of cars. The classification of bad-order cars as to light, heavy, general repairs or steel work, or other special work, should be specified before reaching the repair track. In this way the work would be specialized, the output increased and the cost diminished.

Discussion

An interesting discussion followed the presentation of the report from which it appeared that many of the committee's recommendations were already in successful operation, particularly the scheduling of work so that outgoing dates were fixed and adhered to. The regular meetings of shop foremen were warmly endorsed. Fuller instructions in regard to the capacity of high speed steel cutters should be furnished to machine men, and the reading of engineering and mechanical literature was strongly recommended, as the adhesion to old means and methods was fatal to progress, and the mechanical journals may be depended upon as a reflex of the best thoughts of the present day in relation to the special departments which they so fully represent.

Election of Officers

The following officers were elected for the ensuing year: President, J. B. Wright, Hocking Valley; first vice-president, G. H. Logan, Chicago & North Western; second vice-president, H. E. Warner, New York Central; third vice-president, T. J. Mullin, Lake Erie & Western; fourth vice-president, C. A. Barnes, Belt Railway of Chicago; secretary-treasurer, William Hall, Chicago & North Western. M. H. Westbroke, Grand Trunk Western, and C. W. Adams, Michigan Central, were elected new members on the executive committee, and R. L. Davies, Chesapeake & Ohio, was made chairman of the committee.

Joint Exhibit Proposed of Railway Mechanical Conventions

At a meeting of the International Railway General Foremen's Association and the Railway Supplymen held at Chicago, during the convention of the General Foremen's Association, a suggestion was made by the Railway Supplymen that much benefit might be gained by holding the various railway mechanical conventions at the same date and place so that the exhibits of the Railway Supplymen would serve jointly for several organizations. The suggestion was favorably received and it was decided to invite the executive committees of the railway mechanical associations to a meeting to be held in the Hotel Sherman on October 4, to discuss the proposition and probably adopt a plan to hold the conventions simultaneously at some central location.

American Welding Society.

The Chicago Section of the American Welding Society held its regular meeting on September 14. S. E. Miller, Rochester Welding Works, and E. Wanamaker, Electrical Engineer, Rock Island Lines, were the principal speakers. A committee consisting of E. Wanamaker and H. B. Bentley were appointed to confer with the parent society, relative to the work to be covered by the Chicago Section.

The Pittsburgh Section has elected the following officers to serve for one year: Chairman, J. D. Conway, secretary-treasurer Railway Sup. Mfg. Association; first vice-chairman, Dr. R. H. Brownlee, consulting chemist; second vice-chairman, H. H. Maxfield, G. S. Mt. Power, Pa. R. R. (Cent. Div.); secretary (temporary), F. W. Tupper, American Welding Society; treasurer, F. O. Gardner, treasurer Pittsburgh Testing Laboratories. An Executive Committee was also elected consisting of twelve members. Those elected to serve for three years are as follows: W. M. Finlayson, assistant to M. M., Carnegie Steel Co. (Homestead Works); Geo. H. Danforth, construction engineer, Jones & Laughlin Steel Co.; J. A. Warfel, Dist. Manager, Air Reduction Sales Co.; E. C. Sattley, general manager sales, Page Steel & Wire Co. Two years: A. M. Candy, general sales engineer, Westinghouse Elec. & Mfg. Co.; H. D. Kelley, Dist. Manager, Metal & Thermit Corp.; D. J. Redding, Asst. Supt. M. P., Pittsburgh & Lake Erie R. R.; C. H. Newbury, Supt. Wld. & Cutg., Crucible Steel Co. of America. One year: Charles Crates, superintendent Blaw-Knox Co.; Frank S. Austin, Dist. Sales Mgr., Carbo-Hydrogen Co.; J. H. Rush, Weld. Sales Eng., Rush Machinery Co.; B. P. McDaniels, president, Power Piping Co.

Slide Valve Friction

Recent experiments in calculating the friction of a slide valve working on a horizontal face showed that it was greater than when the valve is vertical in the steamchest, and the average coefficient in a number of tests was found to be 0.0878 for the unbalanced type of slide valve, and 0.0919 for a partially-balanced valve of the Richardson type. The valve resistance was determined by means of an apparatus mainly consisting of a hydraulic cylinder, fitted with a piston and cup leathers, and attached to the valve spindle in such a manner that, by means of suitably connected indicators, a simultaneous record giving a friction diagram, a steamchest diagram, and a steam cylinder diagram was obtained.

While there may be differences of opinion regarding the effect of certain factors on the ultimate results, these experiments are of undoubted service in determining the frictional losses in a slide valve. The unknown factors of the stuffing-box friction, and the friction of the hydraulic piston, for example, need to be deducted to obtain a true reading for the valve friction.

The Valuation of Locomotives

It will be recalled that an Equipment Committee on Federal valuation in regard to the cost of railroad equipment has made several reports all of which have been of much value in the work of obtaining as nearly as possible an exact valuation of the railroad properties. The report on locomotives is now completed, and the available data on the price of freight and passenger cars is now being examined with a view to complete the report as far as the motive power and rolling stock is concerned. The various reports have been made by a general committee consisting of the following experts: General Committee, W. L. Wilt, special accountant, Pennsylvania Railroad; James Partington, estimating engineer, American Locomotive Co.; A. B. Ehst, comptroller, Baldwin Locomotive Works; H. E. Hale, engineer, Eastern Group, Presidents' Conference Committee on Federal Valuation of Railroads. The work of this committee was largely of an advisory and clerical kind and their reports were guided by a sub-committee consisting of P. F. Smith, Jr., manager, Altoona shops, Pennsylvania Railroad (chairman); Henry Bartlett, chief mechanical engineer, Boston & Maine; F. H. Clark, general superintendent motive power, Baltimore & Ohio; C. E. Fuller, superintendent motive power and machinery, Union Pacific; C. F. Giles, superintendent of machinery, Louisville & Nashville; D. R. McBain, assistant general manager, New York Central, West of Buffalo; Robert Quayle, general superintendent motive power and car department, Chicago & North Western. To these were added an equipment committee whose approval of the reports was an essential requisite to their publication. This committee consisted of the following: J. Howland Gardner, vice-president, New England Steamship Co. (chairman); P. F. Smith, Jr., works manager, Altoona shops, Pennsylvania Railroad; W. J. Tollerton, general mechanical superintendent, Rock Island Lines; F. O. Walsh, superintendent motive power, Atlanta & West Point; W. H. Wilson, assistant to vice-president, Northern Pacific; H. E. Hale, engineer, Eastern Group, Presidents' Conference Committee on Federal Valuation of Railroads (secretary).

Many firms engaged in locomotive construction, as well as those engaged in the manufacture of accessories co-operated heartily in the work of the committee, and about 12,000 locomotives came under the committee's investigations, besides a tabulation of the net price of each particular speciality was added to the report, and also supplementary reports from time to time showing the cost of production for each year from 1910 to 1919 inclusive. In this matter the latest supplement was furnished by the American Locomotive Company and the Baldwin Locomotive Works, and also special reference to the total weight of all locomotives constructed by these companies from 1910 to 1919 inclusive, including the total price of each locomotive. From this data the average price per pound of locomotives from 1910 to 1914 inclusive was taken as a basis of 100 per cent, and from this basis the supplementary reports show that in the year 1917 the percentage of cost had increased to 210 per cent in price; in 1918 it had slightly fallen to 206 per cent, and in 1919 had again increased to 212 per cent as compared with the 100 per cent basis of 1910-14.

The accompanying reproduction of a relative price curve of locomotives from 1910 to 1919 inclusive is particularly interesting as showing in graphic details the variation in costs of production of locomotives. It will be observed that the lowest point shown on the price curve occurred in 1914, while the greatest increase in production occurred between 1915 and 1917, with, as we have already stated, a slight decrease in 1918 to be succeeded by a still further increase in 1919, and it may be that the end is not yet.

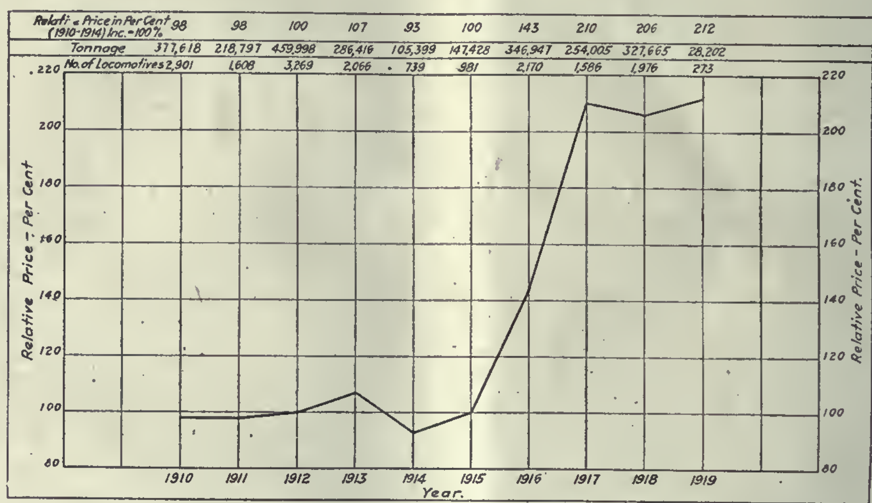

DIAGRAM SHOWING RELATIVE PRICE CURVE OF LOCOMOTIVES FROM 1910 TO 1919, INCLUSIVE

In any event it is well that in the interest of fair play the exact data in regard to the valuation is likely in a short time to be available, and the committee on the mechanical equipment are to be congratulated on their excellent work, and while much has been done heretofore in the endeavor to reach a fair valuation, we doubt if anything so thorough has yet been accomplished in this direction as the report before us. It is well known that much of the work in this direction that has been done by other than experts systematically controlled has been unsatisfactory, and invariably tending to reduce the actual costs of the railroad properties. In proof of this statement we have before us valuations of shop and other equipment, and while the prices of the heavier tools seem fair and apparently reliable, there is little or nothing stated in regard to the details of the work of conveying the heavy machinery or setting it in place, the valuator apparently looking upon the ponderous mechanism as if it grew out of the ground, instead of being as laboriously founded by human hands as were the Pyramids.

We may revert to this again if occasion arises, meantime we will remain hopeful that the admirable work of the Railroad Equipment Committee will serve as a lesson to all who may be wisely selected and entrusted with the work of fixing the values essential to the first carrying out of the aims and objects of the transportation act looking towards a larger measure of justice to the railroads generally, and to a solution of transportation difficulties particularly.

Need of Railway Equipment in the Malay States.

Owing to the result of war conditions it was found impossible to place further orders for railway material in England, but an order for two Mallets and twelve Pacific type locomotives was placed in the United States. The shortage of locomotives is felt very keenly, but progress has been made in railway construction on the East Coast railway with new engine sheds, carriage sheds and freight yards.

Daniel Willard, President of the B. & O. Speaks to the Members of the Veterans' Association

A Good Lesson to All Railroad Men

The high intelligence and activity of the railroad executives during what may be called the transition period from doubt to sound belief has been altogether admirable, and argues well for a closer relationship between the officials and the employes. They are coming nearer to each other and it is high time. If commanders have not the confidence of the rank and file, the cause they fight for is on the broad road to disaster. Common humanity needs companionship and encouragement, or work becomes mere drudgery and begets hopelessness and ill will. Undeserved promotion almost always begets a swelling of the head accompanied with a contraction of the heart. It may be truly said without fear of contradiction that in no department of human endeavor has the heads of departments worked their way upwards more generally by the sheer force of merit than is the case with the railroad officials of today.

In this regard Daniel Willard, president of the Baltimore & Ohio railroad, is a shining example, and in making some extracts from remarks made by him before the members of the Veterans' Association of the road, it will be understood that while perhaps only a comparatively limited few of the heads of other roads have a parallel story to tell of trial and triumph as in the case of the Baltimore & Ohio, all should have the same vision of the ultimate hope and destiny in shaping the welfare of those with whom they are associated in the work of perfecting the problem of transportation in the country in which we live and move and have our being.

In the course of his remarks Mr. Willard said that "the Baltimore & Ohio railroad was the first railroad started in the United States to do a general railroad business. Its charter was granted by the Legislature of Maryland in February, 1827, and the actual work on the project was started in Baltimore 92 years ago this month. At that time the locomotive was almost unheard of in this country and was only in the experimental stage in England. For some years the cars that first ran over the Baltimore & Ohio railroad were drawn by horses, although some experiments were made with sails and one car was actually equipped to be operated by horse power, but that experiment was not a success. In 1832 a small locomotive equipped with an upright boiler was built for the Baltimore & Ohio company, and while very crude, it was a distinct advance in the direction of the use of steam for locomotion purposes. Several engines of this particular type were built and were run on the Baltimore & Ohio railroad for many years. One of these engines, named the "Atlantic," is still in existence, being stored at the present time in the roundhouse at Martinsburg, W. Va. It is still in condition fit to run, and occasionally is fired up and actually run under its own steam for exhibition, or perhaps I should say historical, purposes.

"The science of railroading was new and undeveloped when the Baltimore & Ohio railroad was started. The early reports of that company are filled with accounts of interesting experiments conducted for the purpose of determining some of its fundamental principles. For instance, experiments were made for the purpose of determining whether the flange should be on the outside or the inside of the car wheel. As you all know, it was finally determined that it would be better to have the flange on the inside, and that is the standard practice the world over today.

"The four wheel engine truck which was for a long time a distinctive feature in American locomotive engine design, was invented by a mechanical officer of the Baltimore & Ohio railroad company. The first practical use of the electric locomotive was made by the Baltimore & Ohio company, and the first Mallet locomotive used in the United States was also built for that company and is still in service. The first message ever sent by the electric telegraph was sent from a Baltimore & Ohio building still standing near our Mt. Clare shops. I believe I am correct in saying that the first school for apprentices was also established by the Baltimore & Ohio company, and many other important practices have been inaugurated and developed under the direct charge of the officers of our company. The Boldman Bridge and Fink Truss were invented by Baltimore & Ohio officers and both designs were used with satisfaction for many years, and until the requirements of heavy modern service necessitated a change in design.

"During the great World War, which ended in November, 1918, the Baltimore & Ohio company was again called upon to render a very important service. As you know, all the railroads in the United States were taken over by the President on January 1, 1918, in order that they might be used in such a way as to render the most effective service in connection with the war program. The Baltimore & Ohio company was called upon during the war to move an enormous quantity of coal, steel and iron required for munitions, and food stuffs necessary for our allies, and in order to do this the long haul class of business which ordinarily moves over the Baltimore & Ohio rails between its western and eastern termini was largely diverted to other lines. The Baltimore & Ohio officers and employes of every grade and station rendered most important service in connection with the winning of the war.

"In addition to the work done by Baltimore & Ohio officers and employes in line with their ordinary duties, nearly 7,000 Baltimore & Ohio employes entered the service of the government and put on the United States uniform. Nearly 3,000 of that number went to France and all would gladly have gone if called upon to do so. Of those who went to France 51 lost their lives on the battlefields and double that number were wounded. This also is an honorable and creditable record of which we may all justly feel proud.

"During the period of Federal control it was claimed by many that the magnificent railroad system of the United States, which had been built up on the theory of private ownership and operation, could not in the future be satisfactorily managed on that basis and that either Federal control or government operation would finally come about. Concerning such an important subject as this there was, of course, a wide divergence of opinion. Personally, I always have been and still am a firm believer in private ownership and operation of railroads because I believe this method assures the best and most economical service, and I always have been and am now opposed to government ownership and operation of the railroads. Certainly it is clear that Congress, after a very full investigation of the matter, reached the definite conclusion that it was better to continue the system of private ownership and operation, and the Transportation Act of 1920 was framed with that end in mind.

"It was clearly the intention of Congress to provide, so far as it was possible to do so, a well qualified and intelligent body of men to pass upon the merits of all disputes which might arise between the railroad companies and their employes concerning wages and conditions of employment. The law specifically states that the Labor Board shall fix wages which shall be just and reasonable; not only that, the law lays down certain definite instructions for the guidance of the Labor Board when considering such matters. For instance, the board is directed to consider the cost of living, the wages paid men engaged in similar undertakings, the hazard of the employment and any other fact or circumstance which ought to be considered in connection with such matters. In fact, the Transportation Act of 1920 places the railway employes in a preferred class, because never before has Congress legislated, so far as I know, in the interest of any particular class of citizens. Never before has Congress said that the workmen engaged in any particular occupation shall always and under all circumstances be paid wages that are just and reasonable, and also be given working conditions that are just and reasonable.

"When I first entered the railway service more than 30 years ago, very rarely did one ever hear anything said about the public character of the railroads. As a matter of fact railroads at that time were considered generally to be very much like any other kind of private business. That theory has been entirely changed within the last 20 years, and I repeat that today it is definitely understood that the public interest is paramount. I am anxious on that account that the Baltimore & Ohio company should at all times render such a service as ought to meet and satisfy the reasonable requirements of its patrons. This, however, cannot be done unless there is a full and complete understanding on the part of all the officers and employes, of the duties which they owe the public as semi-public servants, which we all are. I hope you will all keep constantly in mind the semi-public character of your employment. I believe it is now the clear intent and desire of the people as a whole that the railroads should be treated fairly, but at the same time the public will expect to be well served in return. I have frequently said in the past when discussing this matter with officers of the company that I wanted the Baltimore & Ohio railroad to be looked upon as a good neighbor in all the communities which it serves, and I hope you will bear that constantly in mind and endeavor to so perform your duties, to so conduct yourselves as citizens of the community in which you live, that the people will realize that the Baltimore & Ohio company is in fact a good neighbor and is in fact anxious at all times to do anything that it properly may do to promote the interests of the people and of the communities which it serves. This, in fact, is neither more nor less, as I view it, than our duty under the law, and, furthermore, it is selfishly in our best interests.

"I am most happy to be with you today. I have enjoyed the opportunity of meeting so many who have spent their lives largely in the service of our company. I have been glad to meet their wives, their sons and daughters, and I hope you will have a most enjoyable outing. I trust it will be my good fortune to have many more opportunities to meet with you under similar circumstances. As a parting word, I want once more to urge you all to keep in mind the relationship which should exist between all Baltimore & Ohio officers and employes. It should be a family relationship. I do not want you to feel, for instance, that you are working *for* me; I want you rather to feel that together you are working *with* me and *with* the other officers of the company and that we are all interested in making the Baltimore & Ohio not only a useful agency to the public, but also a sound and reliable institution in which people may invest their money with full confidence that the great property entrusted to our charge will be managed honestly and efficiently at all times."

Increase of Railway Rates in Canada.

The Canadian railway companies have been granted an increase of passenger and freight rates amounting to 40 per cent. in Eastern Canadian freight rates and 35 per cent. in Western. The rates, which came into operation on September 7th, will remain in force until the end of the present year, after which a reduction to 35 per cent. in Eastern Canada and 30 per cent. in the West will be made. Passenger rates are increased 20 per cent., with 4 cents a mile as the maximum rate. On January 1, 1921, the passenger rates will be reduced 10 per cent.

Transfer of the Grand Trunk Railway to Canadian National Railways.

The Board of Directors of the Canadian Northern Railway Company have advised the Minister of Railways that the management and operation of the Grand Trunk Pacific Railway System should be placed under the National Railways, and they have recommended that steps be taken to that end.

Annual Convention of the American Railway Tool Foremen's Association

The annual convention of the above association was held in Chicago on September 1-3 inclusive, J. C. Bevelle, El Paso & Southwestern Railroad, presiding. Among the most important subjects discussed was the standardization of boiler and staybolt taps, a report on the subject being presented by E. J. McKernan, chairman of committee, favoring the adoption of the Whitworth standard threads, 12 threads per inch, for staybolt taps, this particular form being already used on several of the leading railroads. The recommendation was adopted.

The reclamation of small tools brought out an interesting statement from the Tool Salvage Company of Detroit, showing that the enterprising company had developed a regrinding of milling cutters and other tools that restored the worn-out tools to their original efficiency, and also by heating and expanding the tools they are enabled to secure increased diameters, in every detail as good as new.

The method of renewing copper linings in the cylinders of wheel presses recently described in the pages of Railway and Locomotive Engineering, and which is in operation in the shops of the Norfolk & Western, was fully discussed and approved. A large number of minor devices were explained and illustrated, notably a collection from the Louisville & Nashville shops at Louisville, Ky., where no less than 41 labor-saving tools and devices had been successfully introduced by the tool foreman in a comparatively short period.

The keeping, distributing and listing of tools were freely discussed and many valuable suggestions made in respect to the same. In this regard it is difficult to adopt standard methods, much depending on the shop equipment and the facilities, much of which are not such as meet modern requirements. The Lehigh Valley shops at Sayre, Pa., may be looked upon as a modern model, but the vast dimensions of that finely equipped repair shop, all under one roof, give excellent opportunities for improved methods.

The subjects selected for reports by special committees at next year's convention embraced—General Tool Grinding and Use of Jigs on Grinders; Forming and Combination of Punches and Dies; Jigs and Devices for Car and Locomotive Work, and General Reclamation of Small Tools and Shop Equipment.

The officers elected for the ensuing year are as follows: President, J. B. Hasty, A. T. & S. Fe. Ry., San Bernardino, Calif.; first vice-president, G. W. Smith, Chesapeake & Ohio R. R., Huntington, W. Va.; second vice-president, Charles Helm, C. M. & St. P. R. R., Milwaukee, Wis., and third vice-president, L. F. Otten, A. T. & S. F. Ry., Ft., Madison, Ia. R. D. Fletcher, 1145 E. Marquette road, Chicago, was re-elected secretary-treasurer, and P. Renfrew was made chairman of the executive committee.

Twenty-Eighth Annual Convention of the Traveling Engineers' Association

Reports of Special Committees—Election of Officers

The annual convention of the Traveling Engineers' Association was held at the Hotel Sherman, Chicago, September 14-17, inclusive. G. A. Kell, Grand Trunk, presiding. In his opening remarks Mr. Kell dwelt on the pressing necessity of exerting every effort on the part of the members to inculcate the saving of fuel, and the desirability of the best methods of handling the locomotives looking towards lessening the cost of operation. Referring to the spirit of unrest among working people generally, he ascribed much of the trouble to the practice of profiteering, inducing high prices. This he hoped would soon be remedied, as there were already indications of better conditions and a lowering of prices. Mr. Kell paid a well-deserved compliment to the members of the association who had shown an unflinching loyalty to their agreements with their employers, and their example might be taken as a model by all who desire to do their part in aiding the efforts of every right-thinking citizen to re-establish a more settled condition among the industrial classes.

Best Methods of Handling Freight Trains

A special committee on the above subject consisting of Frederick Kerby, Baltimore & Ohio, chairman; M. O. Davis, Santa Fe; M. A. Daly, Northern Pacific; F. C. Leonard, Galveston, Harrisburg & San Antonio, and Molon Laquay, Grand Trunk, presented a report in which they emphasized the necessity of not only keeping the locomotive in the best possible condition, but that the cars should also be in good condition in order to avoid delays on the road. The cars should be carefully and properly inspected, and the receiving yards should be such as to make this possible, so that the necessary repairs could all be done at one time. In regard to the important matter of couplers they should all be stretched the entire length of the train. This can readily be done by setting the hand hand brakes on the rear of the train and have the engine pull the slack out. The delay, if any, for inspection is better than delay on the road. In the yard only one track is blocked, and other trains can pass on some other track, following as well as opposing trains are stopped if an accident occurs, and large losses in time and consequent cost occur. When trains are delayed in the yard there is no loss by the delay of other crews not concerned.

When trains are stopped in the yards before the engine is cut loose, the air brakes should be applied with a full service application, so that the inspectors can go over the train and mark up the piston travel and defective brakes or brakes that are cut out, so that cars can be given the proper attention before being sent out of the dispatching yard. If the defect is such that the car should be sent to the shop, it can be taken out while switching the train and avoid having to be done after the train is made up, which frequently delays the train, causing an increase in overtime to the train crew.

An air brake testing plant should be provided in all dispatching yards, and as soon as the train is switched the air should be applied and brake pipe leakage taken up, piston travel adjusted and retaining valves tested. If these necessary details are attended to before the engine crews arrive, all that they will have to do will be to couple the engine to the train and change the brake pipe to the maximum pressure carried and test to comply with the rules that may be in effect on the road.

On level divisions the trains should consist of all through loads as much as possible, and the train should consist of as much tonnage as the locomotive can handle at the average speed of at least 14 miles an hour. If it should be necessary to fill out a train with cars for intermediate points or to add local cars to the train, they should be switched on the first part of the train or station order, so that only the cars to be set off will require to be handled. With the long heavy trains that are being handled at the present time, every means should be thought of in advance in order that it may be kept moving as it is the stopping and starting that not only causes delays but also tends to damage the equipment. It is also well, if possible, to avoid stopping for coal over the division, and also for water as few times as possible.

All long and heavy trains should be stopped with one application of the air brakes, and the engineer should endeavor to keep the slack bunched from the front end. This can best be done by making the initial reduction just sufficiently heavy to run the slack in and follow up with light reductions until the train is stopped. In order to keep the front end from running out, the engineer should make a reduction of about 8 or 10 pounds about 60 feet before coming to a full stop. This is to keep the air brakes applying stronger on the front and to hold the slack on and leave the brake applied on the train when the engine is cut off. Engines so handled and equipped give excellent performances both from capacity and fuel economy standpoints.

In starting a train the engineer must be very careful until he has pulled all of the slack out of the drawbars before fully opening the throttle. There is from 9 inches to 12 inches of slack between the cars, and this will increase on the front end in starting, due to the compression of the drawbar springs and the dead weight of the cars that have not been started. The engine will move about 60 to 70 feet on a 70 to 75-car train before the rear end moves on the level and even more than this on an ascending grade.

In starting a two-engine train on level roads, the lead engine only should start to pull and take up all the slack that it can. Then the second engine should start to pull by opening the throttle gradually until the entire train is started, then increase the throttle opening as may be required. The train should be moved at a slow rate of speed for a distance of just one train length, so that the trainmen can look over the train and in case any brakes are sticking they can be released. Very often it is possible to locate a defective coupler in the train when it would not be noticed at any other time, except when the train is stretched out so far. This will occur at times when couplers are badly worn and the draft spring broken or worn.

It should be noted that the leakage on the air brake testing plant is below the standard allowance, and it should be seen that all necessary repairs has been done before the train is ordered to leave the yard, so that when the road engine arrives in the yard it can be coupled on to the train at once and make the road test. Much of the success of the trip depends on the start out of the yard. The importance of having the train ready to move by the time it is called is readily seen, for one hour delay in the start means overtime on the eight-hour day. The train dispatcher must not stop trains unnecessarily, because an avoidable stop made by a heavy freight train means a loss of time in stopping, then getting the flagman in and starting, and very often the train is parted in trying to start, due to a broken coupler or coupler slipping by which might not have occurred if the train had not been stopped. There is also an excessive amount of fuel consumed by the extra stops and in trying to make up some of the time lost by the stops. There is no economy in loading a freight train so that it cannot move over the division without making overtime.

On divisions where the grades are heavy and it is the practice of using one or more helpers on the ascending grades, it is important that no weak cars be used in heavy tonnage freight trains, if possible to avoid it. With the Mallet and Santa Fe type locomotives having tractive efforts of from 70,000 pounds to 105,000 pound cars with weak end and center sills or weak couplers are very dangerous to handle in trains of this kind. There should be instructions given to all yard masters and car inspectors that cars that appear to be old or of weak construction should be switched out of heavy trains where helpers are used and placed in a train to be run without a helper or a train hauling light tonnage.

It has been demonstrated from time to time that it is not necessary to use hand brakes on freight trains on descending grades any more than it is on passenger trains, when the equipment is properly maintained. With the ordinary air brake, if properly maintained and manipulated, it is possible to handle freight trains on heavy descending grades with the air brakes with a greater degree of safety than with the use of hand brakes, because it is possible to do the braking more uniformly throughout the train and to maintain a more uniform rate of speed, which is very important, as the wheel temperature is less with a low and uniform speed than with the use of hand brokes.

According to the information obtained from the different roads, the permissible brake pipe leakage on trains of 30 to 100 cars varies from five to eight pounds per minute, which is about all the air feed valve will take care of and about the limit of leakage with which an engineer can do a good job of braking. It has been found by actual tests on heavy mountain grades that it is very difficult to release the brakes on the rear end of 75 to 90 cars with a brake pipe leakage of over seven pounds, and if the brakes are not released on the rear end after each application the tendency for jerking the train and excessive heating of wheels is greater.

Some roads are handling trains on level tracks as well as on heavy mountain grades with electric power, and some other roads are figuring very strongly on electrification. While this method of operation applies only to a few roads, we are of the opinion that more roads will take up the matter of electrification in the near future from the fact that with the electric locomotive the terminal delays can be reduced considerably, as well as delays in stopping for water and coal, and it has been demonstrated that an electric locomotive can be run over three divisions of over 100 miles each, by changing crews, without any delays to the locomotive. This would indicate a high point of efficiency from the fact that it could be a no-stop operation from one end of the division to the other. This would eliminate the pulling out of drawbars and damage to equipment due to starting and stopping. It would also reduce the cost of brake shoes and other brake equipment.

On heavy grades the speed of the train is controlled while descending, by regeneration, but it must be understood that by regeneration the speed of the train is only held under control and it will be necessary to use the air brakes to stop the train.

Discussion

Several valuable suggestions were made during the discussion that followed the reading of the report, particularly in regard to the best method of how to make a water stop. Stopping short at the water crane, and then moving the train up slowly to the final stop was recommended. The stopping of the train and cutting off the engine before moving to the water crane frequently involves considerable loss of time. The reduction of damage to draft gear had resulted in the adoption of the method recommended, because damage is frequently caused by brakes sticking following the recharge and release after at water stop.

What Are the Most Suitable Draft Appliances?

The committee in charge of this subject consisting of H. C. Woodbridge, Locomotive Stoker Company, chairman; W. G. Tawse, Superheater Company; W. M. Cooper, Grand Trunk; H. L. Harvey, Chicago & North Western, and T. L. Kenney, Big Four, presented a very full report in which it was stated that as a general principle the most suitable draft appliance is that which will produce the required draft with least back pressure under the varying conditions of locomotive operation. That such draft be developed uniformly is greatly to be desired in order that cinder losses may be reduced and the mixture and chemical union of gases in the firebox improved, and also because the peaks or maximum efforts of intermittent draft are largely responsible for the plugging of flues; the loss in superheat caused by obstruction to the flow of gases in the superheater tubes frequently being as high as 32 per cent.

Development of draft apparatus which gives promise of approximately complying with these requirements has been under way during the past year or two and should be encouraged; but for the immediate need we must confine our efforts to the fixtures at hand or easily obtainable. The required draft in many instances is less than that which will develop the maximum evaporation. Engines in switching service or regularly in light work of other nature may often be run successfully with draft appliances which demand less back pressure than would be required if the same engines were engaged in more severe continuous work.

While the cinder losses will average approximately 6 per cent of the fuel burned, these losses frequently increase to from 18 per cent to 23 per cent during the period of maximum effort. However, the amount of fuel used per unit of work done decreases rapidly and consistently as the tonnage per train increases toward a reasonable maximum. Therefore, in general, the draft appliance should be so constructed as to provide for satisfactory performance at maximum capacity of each locomotive, and fortunately such arrangement will be found as generally satisfactory as is possible with present apparatus during periods of lighter work.

A summary of tests of nozzles were submitted in the reports laid before the recent convention of the American Rail-Administration, Section III, Mechanical and from which the following may be considered as the consensus of opinion on the subject:

"Your committee does not consider the information now available sufficiently complete to justify positive conclusions as to the most efficient shape of nozzle, and is only in position to report that the circular form of nozzle does not result in the highest vacuum and the least back pressure. As to what form will produce those conditions it is impossible to say without an extended investigation involving a long series of test plant observations.

"It seems evident, however, that all preconceived ideas of exhaust jet action must be revised to agree with the apparent fact that the best results will be obtained when the jet contour is interrupted, as is the case both with the internal projection nozzle and with the one having one axis longer than the other."

The committee of the Traveling Engineers' Association continuing their investigations stated further that the increased draft obtainable by use of the four internal projection nozzle is said to be due to the increase in gas entraining capacity which results from breaking up the continuity of outside of exhaust steam column, thus increasing the surface of the steam jet with which the smoke-box gases may come in contact and promoting the intermingling of these gases with the steam jet.

Indicator cards taken during tests with the internal projection nozzle illustrate clearly that at low temperature the steam does not flow so rapidly as at higher superheat, that with low superheat there is higher back pressure and also a lower initial cylinder pressure even when the steam chest pressure is higher for low superheat than for high superheat. This increase in rapidity of flow due to superheat accounts for the "snappier" exhaust of the superheated locomotive; and as the amount of draft depends, among other conditions, on the length as well as the speed of exhaust jet, it might appear that a reduction of nozzle size should accompany the superheating of a locomotive. However, this has not been found necessary in many instances and a conclusion that draft appliance details, including size of nozzle tip, when most suitable for locomotive using saturated steam, should not be changed when superheating apparatus is installed, is sustained by carefully conducted tests at the Pennsylvania Railroad testing plant at Altoona. We are justified, therefore, in using smaller nozzles with superheated steam than were most suitable for saturated steam only as a last resort.

Particular attention was also invited to the nozzle tip arrangement in use on a large number of New York Central locomotives which consists of the usual circular nozzle provided with a so-called "basket bridge," consisting of two splitters set at right angles with each other with the point of intersection directly over the center of nozzle, the splitters being arched to 1¼ in. above the tip at the center. This device is giving very satisfactory service, the use of splitters so arranged having made it possible to increase the effective nozzle opening very materially above the required opening of the plain circular nozzle tip. Engines so equipped give splendid performance, both from capacity and fuel economy standpoints.

AMALGAMATION

The Committee on the question of the Association amalgamating with Section III. Mechanical of the American Railroad Administration, reported favorably, but on motion definite action was laid over until the next annual convention of the Traveling Engineers' Association.

ELECTION OF OFFICERS

The election of officers for the ensuing year resulted as follows: President, W. E. Preston, Southern Railway; first vice-president, J. H. De Sales, New York Central; second vice-president, F. Kerby, Baltimore & Ohio; third vice-president, T. H. Howley, Erie; fourth vice-president, W. J. Fee, Grand Trunk; fifth vice-president, J. N. Clark, Southern Pacific; treasurer David Meadows, Michigan Central. J. D. Heyburn, Frisco, J. P. Russell, Southern Railway, and V. C. Randolf, Erie, were elected members of the Executive Committee, to take the place of the members whose period of service had expired.

Statement of the Association of Railway Executives

A regular meeting of the Association of Railway Executives was held in Chicago last month, Thomas De Witt Cuyler presiding. Among those present were: Hale Holding, president, Chicago, Burlington & Quincy; H. E. Byram, president, Chicago, Milwaukee & St. Paul; C. H. Markham, president, Illinois Central; J. C. Gorman, Chicago, Rock Island & Pacific; W. H. Truesdale, president, Delaware, Lackawanna & Western; W. W. Atterbury, vice-president Pennsylvania Lines; A. T. Hardin, vice-president New York Central Lines; E. J. Pearson, president New York, New Haven & Hartford; Carl R. Gray, president Union Pacific; W. A. Worthington, vice-president Southern Pacific; Howard Elliott, chairman of the board, and J. M. Hanaford, president Northern Pacific; W. B. Storey, president Atchison, Topeka & Santa Fe; W. H. Finley, president Chicago & North Western; S. M. Felton, president Chicago Great Western; H. R. Kurrie, president Chicago, Indianapolis & Louisville; B. F. Bush, president Missouri Pacific; F. H. Alfred, president Pere Marquette; J. M. Kurn, president St. Louis-San Francisco; T. M. Schumacher, president El Paso & Southwestern; David Willard, president Baltimore & Ohio; Fairfax Harrison, president Southern Railway; Frank W. Stevens, president Chesapeake & Ohio; W. H. Williams, chairman of the board, Wabash Railroad, and W. G. Bierd, president Chicago & Alton; also Alfred P. Thom, general counsel of the association.

The principal object of the meeting was the discussion of plans in relation to an improvement in transportation, and at the conclusion of the meeting the following statement was issued by Robert S. Binkerd, summarizing the consensus of opinion of the members present in regard to solving the problems brought before them:

"Since the cessation of federal control we have increased the car mileage from 23 to 26 miles a day, and our plan is to get an average of 30 miles a day out of each car. Each additional mile per day we get out of the nation's freight cars is equivalent to putting into operation 90,000 new cars.

"The Central Western and Northwestern regions are showing good averages in car miles, but the New England region is the most congested. Because of the strike and inadequate terminal facilities, cars in that region are moving less than 15 miles a day.

"The limited earnings ruling is a great handicap to the railroads and the improvement of transportation with the present equipment is all that can be hoped for this year. With a money market flucuating between 7 and 8 per cent. and the earnings of the roads limited to 6 per cent., it is obvious that no extensive plan of rehabilitation can be undertaken.

"We are putting into service about 60,000 new freight cars, 1,250 new locomotives, and 1,250 passenger and milk and baggage cars, using the loans from the $300,000,000 fund provided by the Transportation Act, but these amounts are considerably less than normal, and the roads have not had much new equipment since they went under federal control."

Up to August 24, 4,000,000 more tons of bituminous coal and 3,000,000 more tons of anthracite coal had been handled by the roads than were handled in the same period last year, Mr. Binkerd said. Every day more than 4,000 cars of coal are being delivered to Lake Erie ports for use in the Northwest region, and this amount is more than enough to take care of that region next year. There is no danger of a coal famine, he said, unless something unforeseen occurs.

To handle the crops raised in the West the roads have relocated more than 40,000 freight cars from the East to the West since June 1, according to Mr. Binkerd, and during the same time have moved more than 30,000 coal cars to the mines in the East, and the outlook for the future is of the most encouraging kind.

Raising a Train Shed.

The Delaware, Lackawanna & Western Railroad has nearly completed a project of raising to its original level its Hoboken, N. J., station train shed, the supporting columns of which had sunk irregularly from 5 to as much as 14 or 17 inches in places. This shed is the first ever built of the Bush type with slots for the locomotive smoke stacks. It is 360 feet wide and 630 feet long, covers 14 tracks and an area of about 5 acres and weighs 18,000,000 pounds. It is supported on 207 cast steel columns each set on a concrete foundation resting on 80-foot wooden piles which had settled. The shed was raised in 4 sections by means of jacks at each column in the station to bring the roof to its proper level. The concrete platforms have also been built up and the tracks raised to their original level. The old scheme of wire-glass roofing with large sections of glass which used to break from the vibration has been replaced by a concrete and vault light roofing. The whole project has been carried out without delay to a traffic of 225 trains daily or without inconvenience to the 1,500,000 passengers who use the station monthly.

It is reported that no blame can be attached to the original constructors as it is believed that a secure foundation had been reached in the excavations made at the beginning of the work.

Snap Shots

By the Wanderer

I suppose that it would strike the average superintendent of car equipment all of a heap, as the English maid would say, if someone should suggest that he pay ten, or fifteen or twenty dollars more than he does for a car door. The inference being that the proposed door would be worth that much more in material or workmanship or design, or all three. The real point would be whether it would be worth that much now to the purchaser in wear, tear and ease of manipulation. For example I saw a door on the car of a great trunk line the other day. A line whose engineers are strong in the advocacy of proper doors and proper door fixtures. This particular car was being used as a peddling car in way freight on a foreign road, which was very wrong on the part of the foreign road. So wrong that the door with a proper sense of the unfitness of the uses to which its mother car was being put, refused to open. It finally yielded, however, to the persuasive influence of a crowbar in the hands of two husky brakemen. Then there was a period of unloading and in that process several cases of a tasty beverage were placed near the door to be handy for the men unloading. But, when the work was done the door refused to budge, would not be closed and it was left open. So that if that beverage reached destination it was because it again caught the eye of no wanderer. Now here is the point. Would or would it not pay to make car doors so that they could be opened and closed easily? The objection is first cost and the charge for maintenance, which would be something as against the average nothing of to-day. The advantage would be the saving of time, as in the case cited, about ten minutes for a whole train crew; and the better protection of lading against theft. Suppose it were thirty dollars the car in first cost and the car lives twenty years. At six per cent compound annually we would have a total cost to be funded of about five dollars a year. The loss of one case of tastely beverage or a total of an hour and a half or two hours for a train crew, in a year would nicely cover the funding of the cost and interest. But then there would be really nothing to show for it but possibilities, and possibilities are too intangible to be of much use as an argument in this work-a-day world.

And that reminds me of a true story of this same thing. There was a big railroad, a very big railroad, and one that prided itself on its bigness and greatness. And it had a superintendent of motive power. Not a technically educated man, to be sure but one who was credited by all of his friends and associates with an endowment of a very large modicum of horse sense. He was modest withal but was so advertised, against his will, by his fellow officers, that his name was known throughout the length and breadth of the land. The railroad also had a superintendent who had been brought up in the old school and who thought that whatever is is right. Now this was in the days when small things were rapidly becoming big things, and its neighbors were using moguls and consolidations, while the greatest of all hung to eight wheelers for its freight work. And great was the wonderment on the part of the S. M. P.'s friends that he should be so backward in using what others found to be so profitable. And so, once upon a time, a friend asked a fellow officer why it was, that a man of such great common sense should so fail to see the advantages of the new power.

"Well," said the fellow officer, "if you should go to your president and say, 'We are about to buy ten locomotives. Heretofore we have paid $10,000 each therefor. Let us now pay $12,500, and we will save the extra $2,500 in a year's time by the increased loads that we can haul.' And then your president should say, 'Go to, you had best not spend that extra $2,500 and then you will not have to save it.' If you had made such suggestions on several occasions, and this had always been their reception, the time would come when you would cease to make suggestions whose value rested upon some intangible and uncertain gain."

And so it is, probability is not certainty and to put good hard tangible dollars into a device that the more it saves the less it appears to save is not a process that is largely encouraged in railroad or any other field of affairs.

It is interesting sometimes to see what little things will delay a train and delay it badly. I was waiting for a train the other day on a road that never runs the few trains that it does run on time. This particular train had been losing time until it was a couple of hours late when it pulled into the station. Just at the end of the station platform there was a plate girder bridge of a length a little greater than one car. By careful signaling the conductor stopped a three passenger car train so that the rear platform of car 1, both platforms of car 2, and the front platform of car 3, were on the bridge. The rear platform of car 3 was an observation platform and not opened. The discharge and intake of the passengers was very heavy, practically unloading and reloading the whole train, and all had to be done through the front platform of car 1; just 12 minutes was occupied in the process. Now if the train had run ten feet further before stopping. The front and rear platforms of car 1, and the front platform of car 2, would have cleared the girder and been free to be used. If it had stopped six feet short of where it did, then one platform of each of the three cars would have been free to use and the time of unloading and loading would have been eight minutes less than it was. There was no physical reason why the stop should not have been made as indicated and yet, day after day, the passengers of the three cars drag their slow, very slow, way through the length of the train because no one sees to it that they are not obliged to, and more minutes are added to the rapidly accumulating delays.

Speaking of delays, "Is this train ever on time?" I asked of a porter, the other day. "No, sah," came the reply. "That is to say, except about once in four months they get after them, and then for a week they runs on time. After that they just gradually settle back to being late until they gets after them again." I wonder what sort of supervision or interest the superintendent exercises that permitted such a condition to exist.

This matter of late trains is about the most aggravating annoyance to which the traveling public is subjected. It is bad enough for those who are on the trains that are steadily losing time, but it is infinitely worse for those who, innocently trusting to a time table, go to the station at the time scheduled and then are forced to wait minutes and hours for a delayed train. I could name trains on more roads than a few that are never on time, and yet no one dares trust to their being late. Now what is the use of a schedule that shows a train making thirty miles an hour when it can't make fifteen? I know of one case where a train is scheduled to run 105 miles in five hours and a half, and never makes it in less than 7 hours, and every day a score or more of passengers sit around for an hour or more waiting for the train. There is every reason in the world why the train should not make more than fifteen miles an hour, but why keep up the farce of a schedule that is never observed? Why load the despatcher's office with orders giving extra time on No. —, when a half hour's work in this case and a change of standing type would put the whole thng on a working basis? Lord Dundreary sagely remarks that "there are somethings which no fellah can find out." This seems to be one of those things that no fellah can understand and I doubt if any railroader can explain. There is hardly a railroad in the country whose skirts are clean. There is a great deal said and urged about currying favor with the public, and yet no railroad official has ever seemed to have thought of using a time table that can be run to, as an avenue to this goal. There is a certain theatrical manager in New York who is known throughout the land as being preeminent in his profession. He never stages a failure, and to go to one of his theatres is a guarantee that one will see a finished production. The manager is more than careful in the selection of his casts, but having once cast an actor for a part, he does not discharge him. If the man or woman is unable to portray the character up to the high ideal of the manager, the latter neither discharges the actor nor permits an unfinished production to come before the public. He does the simple thing of cutting the part to suit the capabilities of the actor to do a finished piece of work, and the public acclaims his success. Why isn't a time table a parallel case? If the traffic, or the engine or the crew or any other of a thousand and one things prevent a train from running on schedule time; it stands to reason that, if the train can run at all, there is some schedule that it can run to. So why not increase the running time to suit the trains and at least be spared the anathemas of an exasperated public?

New Bridge at Niagara

Test-pits have been sunk near Black Rock, on the Niagara River, a few miles from Bridgeburg, to investigate the nature of the foundation work that will be required for the construction of a bridge over the Niagara River to Grand Island. M. C. Spratt, attorney for the New York Central Railway, declares that options on all necessary property have been secured. The cost of the proposed bridge, he states, will be $4,000,000. It will be a combined highway, tramway and railway bridge, and will be used jointly by the Canadian Pacific and New York Central lines.

The bridge will be built by the Canadian-Niagara Bridge and Development Co., which was recently granted a charter by the Dominion Government. The bridge will span the river from Black Rock to Grand Island and from Grand Island to a point on the United States shore near the Wickwire Steel plant. The Michigan Central Railway is placing materials that will be needed for a construction spur from Bridgeburg. Seven C.P.R. engineers are at work on the surveys on the Canadian side of the river. Construction of the railroad bridge, it is predicted, will tend to discourage the Peace Bridge project which has been promoted for several years along the frontier on both sides of the river. The location is believed to be the most available in the vicinity of the railroads.

The Smallest Public Railway in the World

By W. Parker, President, Railway Club, London, England

An American visitor to Europe on landing at Liverpool or Southampton is at once struck by the small size of the locomotives of the British railways as compared with the mammoth proportions of the mighty machines to which he is accustomed in the Western world. True, his astonishment, not unmixed with amusement, is soon supplemented by an admiration for the excellent running made on the English main lines, but if his itinerary in the "old country" takes him into the lake-lands and high-lands of Cumberland he will there find an independent little line which claims to be "the smallest public railway in the world."

Known as the Eskdale Railway this line is 7⅛ miles in length and the rail gauge is one of 15 inches only. It is leased to a London company—Narrow Gauge Railways, Limited. The passenger working is carried on by midget express engines, built to a scale of one-quarter the size of ordinary British main line locomotives but in other respects exactly the same in construction and appearance. The photograph used to illustrate this article is of a new Pacific type express locomotive built by Hunt & Co., Bournemouth, and put into service for the 1920 summer season. It is named "Sir Aubrey Brocklebank" after a worthy baronet whose property the railway skirts for about two miles.

ESKDALE RAILWAY WITH NEW ENGINE ARRIVING AT BECKFORD, THE TERMINAL OF THE LINE, WITH THE FIRST REGULAR TRAIN.

The leading dimensions of the locomotive are: Bogie and trailing wheels, 9⅜ in. dia.; cylinders, 4½ in. dia. by 6¾ in. stroke; coupled wheels, 20 in. dia.; boiler, length, 5 ft. 11½ in.; diameter, 22⅝ in.; firebox, 1 ft. 8½ in. long; heating surface, tubes, 11,672.7 sq. in.; firebox, 1,412.6 sq. in.; total, 13,085.3 sq. in.; frames, length, 10 ft. 10¼ in.; boiler center above rails, 2 ft. 6¼ in.

The line begins at Ravenglass on the Furness Railway and between that company's property and the Eskdale Railway there is a narrow-gauge siding to facilitate trans-shipment of goods from the full-sized wagons of normal British railways to the miniature wagons of the Eskdale line. Other than Ravenglass there are six stations—Muncaster, Irton Road, Eskdale Green, Beckford, Dalegarth (a new one opened this year) and the terminus—Boot. The country served is in British eyes a mountainous district, but to those familiar with the Rockies, the mountains of Cumberland will appear as miniature as the locomotive illustrated.

There is an excellent service of passenger trains, including a non-stop morning "express" from Ravenglass to Dalegarth—a station provided with a well-fitted refreshment room—a much appreciated public convenience. The non-stop train slips a coach at Irton Road station and this is the only instance in the world of such an operation being in practice in a regular service on a miniature railway.

The Channel Tunnel.

A resolution has been presented to the British Parliament urging the construction of the Channel tunnel connecting the railway systems of France and England, claiming that its completion would be a fitting emblem of the new friendship of the two countries. There has never been any serious objection to the scheme. The financial aspect of the project has been declared sound, and the French government is quite prepared to bear its share of the cost.

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Freight Car Equipment.

The earnestness with which the railroad executives are taking up the work of rehabilitating the motive power and rolling stock of the railroads is having its reflex action on the leading officers of the various departments and incidentally on the rank and file. This is as it should be, and we are convinced that the dark days of unauthorized strikes are gone as far as the railroads are concerned. While, as we have stated before, there is not a complete equalization of the wage rates among all classes of men employed in the railroad service, there is a general feeling that this will be rectified in time. Meanwhile the men are at work in earnest and the results cannot be other than the best that human agency can accomplish.

Perhaps the most serious and pressing question is the best and quickest means of bringing the freight car equipment to a condition that will meet the growing requirements of the transportation situation of the entire country. The loss through this stagnation of our industrial life has been appalling. Like a hardening of the arteries it is not only a sign of physical decay, but is a sure approach to physical paralysis, and the eyes of a long-suffering people look patiently and hopefully for a remedy. The remedy is here now and is being applied and all we need is a little more patience and coincidently a little more encouragement to keep the lamp of hope burning in the forehead of honest endeavor.

The General Foremen.

The lesson to be learned from the Convention of the International Railway General Foremen's Association, which we report elsewhere, as well as the spirit manifested at other identical conventions among the railway men, is the fact that the best men are intensely in earnest in their effort to do the best they can if they get fair play. The general foremen occupy an important position in all centers of industrial activity. The great bulk of them have been chosen to fill their positions from some outstanding feature in their characters in the matter of being able to get the best out of other men. They are not always the best mechanics themselves. We recall the discussing of the merits, or rather the demerits, of an appointee to a foreman's position among a group of workmen; one disgruntled mechanic summed up his objections by stating that the newly-appointed foreman could not file straight. Another of a more philosophic turn replied that he, the foreman, could make others file straight. This is the paramount essential quality without which individual skill alone does not assume a leading position. Indeed, it is a noticeable fact that the most adept mechanics are not infrequently left as specialists in some branch of the trade where they can wrap themselves in a mantle of self-complacency and remain serenely satisfied.

The general foreman has a different role. He is expected to know everything, and while experience is a real necessity to acquire this breadth of vision, constant reading is the royal road to success. The real student who reads every engineering book or journal that he can lay his hands on gains more knowledge than can be gathered in the lives of twenty unlearned mechanics who misspend their leisure hours in unprofitable ways. That there are general foremen who suffer from a swelling of the head is no more than should be expected. Learning should teach us humility, because the things that we learn to know, even in a long lifetime, are so small compared to the things that we do not know, that we might well bow our heads in shame. In this regard, however, the world is making good progress. In the memory of many still living the time was when the general foreman was chosen from among those who could swear the loudest. Those days are gone forever. The men who read and study run the world. The student of human nature, guided by tact and self-repression, will lead other men to higher and better results than the domineering bully who becomes an object of ill will, and who induces a spirit of rebellion among those whom chance or fortune has placed under him.

The general foreman should not only be self-respecting, but he should respect others. To take a poor mechanic who may not have had much experience and make a good mechanic out of him is adding to the world's wealth. To find fault is easy. To bring out the best that is in us is genuine leadership.

Compensation Laws.

Men who declare that labor is given no consideration by the lawmakers of America have forgotten, or perhaps they do not know that laws were enacted during 1919 to protect the lives and health of labor, contribute largely to the constructive movement, supported by both employers and employees, to help solve the problem of industrial unrest by applying legislative methods, not as a matter of sentiment, but of sound economics.

This is indicated by the adoption of workmen's compensation in four more states—Missouri, Tennessee, Alabama and North Dakota, the last named state enacting an advanced law which provides for administering the compensation insurance in an exclusive state fund. There are now only six states, and these non-industrial, and all in the South, remaining without this form of accident protection. This means that in the short space of eight years workmen's compensation has been written into the statutes of 45 states and territories in addition to the model act of the Federal government for its million cilivian employees.

The Making of a Machinist.

On page 304 of the present issue of RAILWAY AND LOCOMOTIVE ENGINEERING we publish an article verbatim as it came to us from a railroad man of long and wide experience, particularly touching the machinists and those supervising them. We desire to make no comments on the views advanced, but it leads us to remark that there has always been a good deal of misapprehension in the minds of young men desirous of learning the machinist's trade, and those engaged in learning it, about the advantages and disadvantages of certain shops as compared with others. There seems to be an opinion almost universal that the trade as practiced can only be learned in some large manufacturing establishment provided with all modern tools and facilities for doing work. This is a gross error, but it undoubtedly prevents many young men desirous of learning the machinist's trade from entering some less pretentious shop, through waiting for the opportunity to begin work in one of the larger shops—opportunities that may never come around. Not only so, but many boys who enter the smaller shops, work all through their apprentice time under the discouraging belief that in the proper sense they are not learning the trade as it ought to be learned. While many large moderately-equipped shops afford good opportunities for wide-awake boys, alive to their interests, it is beyond much question a fact that as a rule the small shop—the genuine machine shop—afford better opportunities for the same class of boys. There is a wide difference, and this is generally lost sight of, between learning to use machine tools and learning the machinist's trade.

We have occasional complaints from young machinists in which they state that they are trying to learn the trade in a railroad shop that has few of the modern machine tools that are to be found elsewhere. In fact they complain that they know nothing of many tools except by reading about them. They seem to doubt that they can learn the trade properly in a shop poorly equipped with good modern tools with which they are expected to do first-class work. In this sentence there is given the best reason for remaining where there is an opportunity to do good work with tools that require a good deal of planning to get good work done. This is the most valuable experience that an apprentice can go through. A man who can execute first-class repairs on locomotives with tools ill suited for the purpose is certainly a first-class machinist.

We recall an instance of a locomotive on trial breaking a bolt on the outer end of a crank pin, and a young machinist complaining to the master mechanic that beyond a ratchet and drill he could find no tools. The master mechanic philosophically replied that anybody could do the job with fine tools but it took a clever mechanic to do a job without tools. This set the young man thinking and he inquired of the engineer if he could move the engine alongside the end of an adjoining house. The engine was promptly moved and two or three blocks of wood and an old coupling link formed a brace for the ratchet, and the operation went on.

Being obliged to contrive ways and means as well as do the work, is one of the advantages an apprentice is likely to enjoy in a small shop, and in the future this will generally outweigh the advantages of the use of special tools acquired in the better appointed shop. In fact, the use of special tools is something the apprentice in the small shop, where he is required to do good work, need never trouble himself about. He will never need to learn to use them. When the opportunity comes he will use them without learning. Learning the machinist's trade is learning to do machine work with the tools and appliances at hand, and the best part of it—in fact, about all of it—is in knowing how to adapt means, good or bad, to an end. It is curious in the present day to find a machinist apprentice complaining because he is debarred from using the finest tools, because in the earlier days the mere operation of machine tools was not considered machinist's work. It was looked upon as the work of a skilled laborer.

Another point upon which mistakes are frequently made, is attaching undue importance to the kind of work done in a machine shop. There can be no objection to following one's inclination in this matter when it can be done as well as not, but the real objective point is to learn to shape metals, and in the future it will not make any difference whether the pieces shaped go into a steam locomotive or a car truck.

It must not be imagined for a moment that we decry the use of fine tools. Labor saving tools are in the fore part of our modern civilization, but it is not too much to say that there was more to be learned in the machinist trade by chipping and filing the slide valve face to a perfect fit than by watching a planing machine performing the same operation, although the latter can do the job, perhaps, in one-twentieth of the time.

Cast Iron Wheels.

The Bureau of Standards has recently worked out a number of improvements in solving the problems of the railroad material industry. Among others it has nearly completed investigation of the graphitization of white cast iron upon annealing. This problem arose in connection with other investigations of the properties and characteristics of chilled-iron car wheels and in particular the best range of annealing temperatures. This was brought to the attention of the Bureau by one of the car-wheel manufacturers. The composition is so chosen and the wheel is so cast that the tread and inside of the flange show white iron and the remainder graphitized or gray iron. In order to relieve the stresses set up during the cooling of the wheel under drastic conditions, the wheels are piled in pits while red hot and allowed to cool very slowly. Investigation developed that the highest temperature at which no graphitization of the tread and flanges takes place is about 700 degrees Centigrade, which is also the maximum annealing temperature for car wheels.

A very large percentage of car-wheel failures are attributed to stresses caused by heating of the tread by brake action, the central part or hub of the wheel remaining relatively cool. It is the purpose of the investigation to determine and record for adoption the most suitable material and design of wheels to resist stresses of this kind. In this investigation the tread of the wheel is heated by passing an electric current through a circular resistor insulated from the tread. The wheel remains stationary, thus readily permitting the taking of the temperature and strain-gage readings. Considerable differences have been found in the behavior of wheels differing in design and weight.

Rotatable Coal Hopper for Locomotives.

Firemen on big locomotives find promise of lightened work in the rotatable coal hopper that has been invented for engine tenders. This invention is so planned that the coal is kept handy at the firing deck, making it an easy matter for the firemen to reach the coal without shoveling from the rear of the tender or using power apparatus. This special hopper is in the form of a great segmental tub, or drum, having a diameter that is the approximate width of the tender. This drum is inclined toward the firing deck; it is so mounted on a ball-bearing center plate as to turn readily. In its outer wall are openings, one for each segment, through which the coal falls by gravity. As soon as the coal is emptied from the segment, the brake that controls the drum is released. Naturally the greater weight above the center of the drum makes it rotate, bringing the next loaded segment into position.

Electric Locomotives on the Swiss Railways.

It is reported that several types of single-phase locomotives are in operation on the Smiss railways. The first is a 2-6-2 type of passenger locomotive built for the Gothard Railway, with two motors, each geared to a countershaft and driving by the crank and connecting rod action, usual in the large Continental electric locomotives, on to the coupled wheels. The weight is 91 tons, and the maximum speed is 47.5 m.p.h. Each motor is rated at 675 h.p. continuously, or 825 h.p. for one hour, and is of the series compensated type with 12 poles. A maximum tractive effort of 30,000 lbs. is available. The locomotive can tow a 215 ton train up a 2.6 per cent grade at 31 m.p.h., and when starting up such a grade, can attain this speed in 4 minutes. Another locomotive of the 2-4+4-2 type, with two articulated underframes, is also described. Each group of driving wheels is driven by its own motor by connecting rods, but otherwise the equipment is the same. The motors here are of 450 h.p. continuously or 560 h.p. for one hour, and are provided with regenerative braking arrangements. These locomotives weigh 113 tons and can draw a 300 ton train up a 2.6 gradient at 31 m.p.h. and exert a maximum tractive effort of over 40,000 lbs.

Eight-Coupled Switcher Locomotives for the Cambria Steel Company

The Baldwin Locomotive Works have recently delivered two eight-coupled switching locomotives to the Cambria Steel Company which were designed in accordance with the regular practice of the builders. The design is simple throughout, with all parts of ample strength for severe service. These locomotives operate on maximum grades of 1½ per cent combined with curves of 12 degs., and they are capable of traversing curves as sharp as 24 degs.

These locomotives are notable chiefly because of their very high capacity. They exert a tractive force of 68,000 lbs., which has not been exceeded by any other eight-coupled non-articulated locomotive thus far completed by the builders. The weight on driving wheels is utilized for tractive purposes to the fullest extent that is desirable in a switching locomotive. The engines operate on rails weighing 85-100 lbs. per yard.

The boiler is of the straight top type with a wide firebox and has the unusual diameter for a switching locomotive of 86 ins. The front end of the firebox is supported by three rows of Baldwin expansion stays.

The grates are arranged with drop-plates at the front and rear, and the ash pan has a single hopper of large capacity. A fire-door of the power operated type is installed.

The frames are 6 ins. wide, of heavy construction, each frame being cast in one piece with a single front section to which the cylinders are bolted. The transverse braces include steel castings at the second and third pairs of driving pedestals which extend the full length of the pedestal jaws. The frames are also braced transversely between adjacent driving wheels.

The locomotives are cross equalized in front and the equalization system is divided between the second and third pairs of driving wheels.

The valve motion, which is controlled by a Ragonnet power reverse, is of the Walschaerts type, designed to give the valves a lead of ⅛ in. The cross-head links are attached directly to the wrist-pins, an arrangement which simplifies the construction and reduces weight and is desirable provided there is room for a sufficiently long combining lever.

With a maximum height limit of 14 ft. 8¾ ins. and a width limit of 10 ft. 2 ins., it was necessary to give careful attention to the location of the boiler mountings. The sand-boxes are four in number, placed two right and two left, and the bell is mounted on the round of the boiler on the left hand side. The cab roof is shaped to conform to the Pennsylvania Railroad clearance diagram.

The following are the general dimensions:

Gauge, 4 ft. 8½ ins.; cylinders, 27 ins. by 30 ins.; valves, piston, 14 ins. diam. Boiler, type straight top; diameter, 86 ins.; thickness of barrel sheets, ⅞ in.; working pressure, 205 lbs.; fuel, soft coal. Firebox, material, steel; staying, radial; length, 114 ins.; width, 72¼ ins.; depth, front, 77¼ ins.; depth, back, 62⅜ ins.; thickness of sheets, sides, ⅝ in. thickness of sheets, back, ⅜ in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, 9/16 in. Water space, front, 6 ins.; sides, 6 ins.; back, 5 ins. Tubes, diameter, 5½ ins. and 2 ins.; material, steel, iron; thickness, No. 9 W. G., number 40; length, 14 ft. 11 ins.; No. 12 W. G., number 237; length, 14 ft. 11 ins. Heating surface, firebox, 211 sq. ft.; tubes, 2710 sq. ft.; firebrick tubes, 27 sq. ft.; total, 2948 sq. ft.; superheater, 750 sq. ft.; grate area, 57 sq. ft. Driving wheels, diameter, outside, 56 ins.; diameter, center, 48 ins.; journals, main, 12½ ins. by 13 ins.; journals, others, 11 ins. by 13 ins. Wheel base, driving, 16 ft. by 0 ins.; rigid, 16 ft. by 0 ins.; total engine, 16 ft. by 0 ins.; total engine and tender, 52 ft. by 2 ins. Weight, estimated, on driving wheels, 270,000 lbs.; total engine, 270,000 lbs.; total engine and tender, 425,000 lbs. Tender, wheels, number, 8; wheels, diameter, 33 ins.; journals, 5½ by 10 ins.; tank capacity, 8000 U. S. gals.; fuel, capacity, 14 tons; tractive force, 68,000 lbs.; service, switching.

EIGHT-COUPLED SWITCHER TYPE LOCOMOTIVE FOR THE CAMBRIA STEEL COMPANY.
Baldwin Locomotive Works, Builders.

Domestic Exports from the United States by Countries, During July, 1920.

STEAM LOCOMOTIVES.

Countries	*Number*	*Dollars*
Belgium	12	663,000
France	35	1,050,000
Poland and Danzig	37	1,797,040
Canada	5	29,525
Mexico	1	17,500
Cuba	4	85,570
Argentina	1	16,720
Chile	11	265,196
Venezuela	1	8,865
China	13	660,575
British India	3	39,000
Japan	2	15,010
Philippine Islands	9	94,305
Total	134	4,742,306

The Upkeep of Freight Car Equipment

Delays Can Be Avoided by Making Proper Inspection and Repair

As the fall and winter season approaches the various railroad clubs are already discussing the subject with a degree of earnestness that is doubly gratifying, bringing as it does the best expression of the best thoughts of the best men who by experience are not only qualified to speak on the subject, but who are being listened to earnestly and thoughtfully, and thus sowing the seeds that will blossom with noble deeds.

Among these we observe the Central Railway Club has already discussed the subject at Buffalo, N. Y., at its regular meeting on September 10. J. W. Sanger superintendent of rolling stock, New York Central Railroad, presented a paper on the "Upkeep of Freight Car Equipment" in which he claimed that "facilities are the most important in car repairs next to labor, up-to-date shops equipped with modern machinery and labor saving devices." Being limited to taking care of the equipment it must be realized that a 100 per cent output cannot be had at all times; particularly is this true during the winter season. For obvious reasons the facilities for repairs have not kept pace with the increased equipment. This matter should be one of careful consideration with a view of increasing the facilities as quickly as possible.

Shop organization is also a vital point, and in order to produce the maximum output should consist of capable men. The most important of these are the shop superintendent as general foreman and his assistants. It is generally found that when the work is divided better results are obtained than to have the entire shop or shop yard covered by one man, as this practice makes the head of each division responsible. Junior supervisors should be educated to fill the position immediately ahead of them, so that in the absence of the foreman the work will proceed without loss of efficiency.

Men in supervisory capacities should be selected from the ranks when possible to do so. This practice is an incentive to others. They should be men of a good personality, broad minded in their dealings with men and thoroughly conversant with the details of the work.

Valuable results are obtained by holding monthly meetings of the supervisors, bringing them into closer touch with each other and the practices in vogue at their respective points. Meeting places should be changed from time to time giving all an opportunity to observe the conditions at the different points. Much valuable information can thus be obtained that will result in saving and greater efficiency and due credit given to those who are responsible for same.

The shortage of material is a handicap in production, often necessitating the substitution of one kind for another. Careful attention should be given to the use of material, that none is wasted and all is used to the best advantage. Full cooperation should be had between the mechanical and stores departments in the handling of material that no unnecessary delay be had in supplying material at hand. Advantage should be taken of the scrap dock as much good material can be obtained. The necessary machinery and supervision to reclaim material should be furnished.

Referring to general repairs this has reference to both wooden and steel equipment receiving heavy repairs or that are rebuilt, at which time due consideration should be given to the strengthening of all weak parts, the application of betterments, such as steel underframes, steel ends, improved doors and fixtures, etc., the thorough overhauling and modernizing of trucks, eliminating unnecessary parts and bolts, and providing safety irons to prevent brake beams falling down. After the completion of general repairs a final inspection should be made to know that all parts are in a serviceable condition before the car is released for service.

Light repairs refer to cars repaired on the ordinary repair track and comprises such repairs as replacement of draft timbers, and sills, sill splices, parts of floors, parts of roof, doors and door fixtures, journal boxes, column castings, truck bolsters, side bearings, brake beams and connections, etc.

Cars on light repair tracks should be gone over carefully for defects which may send them to the heavy repair track and avoid making light repairs when the condition is such as to warrant general overhauling. In connection with the light repairs enumerated, attention should be given to the brake equipment doing all the necessary work to put the brake in first-class operative condition.

This is also an opportune time to inspect the car for worn parts, spreading of cotter keys, adjustment of the piston travel, seeing that proper connections and brake levers are applied and that the hand brake and uncoupling levers are efficient, and periodical packing of boxes. If this is done it would prevent the cutting out of cars when returned to service.

Running repairs is generally understood as repairs made in the classification or train yard, either by inspectors or what are termed "Follow-up Men." It should be impressed upon all our minds the importance of having the little things taken care of which are at times neglected; that is, renewing short or broken knuckle pins, worn-out brake hangers, keys and bolts, the application and proper spreading of cotter keys, removal of worn brake shoe keys, application of missing parts and correction of safety appliance defects. At this time the hand brake should also receive a thorough inspection, journal boxes should be examined to see that brasses and keys are in place, that no sign of previous heating exists, and that packing is in its proper place, and there is enough lubrication to run the car to its destination. By giving proper attention to cars in the classification yard, which, of course, includes proper inspection, nearly all of our road delay and expense of setting out cars en route could be avoided.

Quite frequently we hear complaints from other departments on account of too much time being consumed in inspection and repairs in the classification yards, and as already referred to, it should be clear that inspection and light repairs are very necessary to insure the train going safely to its destination without delay. While the work should be done as quickly as possible we should insist upon proper time for inspection and repairs being allowed to accomplish them.

In conclusion the equipment department of the railroads is passing through and experiencing one of the most strenuous periods of its history. The demand that has been made upon it by the operating departments of the railroad, due to the necessity for car equipment suitable for transportation purposes, has tended to make it necessary to use all classes of equipment to the maximum. We have been called upon to supply cars not for the commodities for which they were originally built, but for other classes of service for which they could be fitted by temporary repairs. As a consequence we now find ourselves with equipment on hand which will require some time to build up to its former usefulness and which cannot be very well accomplished unless all railroads provide themselves with newly constructed equipment which can be placed in service to relieve equipment now running, to enable the cars to be brought into the shop and receive general repairs or overhauling which will fit them for the service for which they were originally built."

Not only so but on relieving the delays in transportation it would be found that the high price of commodities would be reduced.

The Maintenance of the Equipment Department

Complaints Analyzed by John Mitchell

The railroads have gone back to private control, they have been granted generous increases in both passenger and freight rates, employees have had their compensation increased so that they are in better position to cope with the H. C. L. and everyone should be happy, except, perhaps, the Plumb Plan followers. Such is not the case, however, in the mechanical end of our railroads, as there is a continual and continuous plaint from this department which seems to emanate from every possible source.

Careful observation for the past two years after coming into intimate contact with mechanical officials high and low, in the Eastern States, would convince anyone that the assertion that there is something wrong in the mechanical end and that some action must be taken to correct it, is not speaking at random or from hearsay.

In attempting to itemize the troubles as they come from all sources they would arrange themselves about as follows:

1st—There is a shortage of skilled men, principally machinists and boilermakers (there is one engine house that has tried without avail for the past five months to secure one pipefitter).

(a) This shortage seems to be attributed to the fact that there was a quick change from two shifts to three, which created a shortage of 33⅓%, that this came at a time when more skilled men had left the railroad service than had ever been dreamed of before and a large percentage of them have not and will not return, as they find outside work, such as automobile work, etc., pays as much if not more, is cleaner, the hours more congenial and often other considerations that are worth while. This one-third shortage is actual, as in changing from two shifts to one, with the same number of men, the man hours worked is 33⅓% less.

(b) Overtime is practically out of the question, except for emergencies, as the higher officials will not stand for the excessive cost of overtime, which is far above the time and a half. This seriously handicaps the local officials at times, although it is probably a good thing, as overtime work is never economical or very satisfactory and offers only temporary relief, which, under other conditions, might be depended upon for permanent relief.

2nd—There are charges and counter charges, accusations and denials as to the efficiency of so-called labor. Complaints are generally more or less vague and a very good answer or settlement of this question was given some time since by a veteran master mechanic, who came up from the ranks. He stated there was no slacking of labor and as proof went back to the old days when a considerable percentage of the men were out of a job for part of the day and recalled how often he had told an "Old Head": "You keep yourself out of sight today, as I am busy finding jobs for some new men and haven't time to find you a job." We can nearly all look back to such days as these when perhaps every third day we did only half a day's work, not because we were prone to work, but because the "boss" could not or did not find us a job. Compare these conditions of more men than work with those of to-day when every man has, first thing in the morning, more work than he can finish that day, and the foreman's chief duty is to try and figure out how he can pry enough men loose from routine work to handle the emergency or miscellaneous jobs. There is laziness and inefficiency, but as for a general decline in efficiency it is a hard thing to prove and has not been proven as yet. This M. M.'s proof seems to outweigh everything offered on the other side.

3rd—There is a lack of pride in workmanship, which once so distinguished and isolated, into an exclusive and beloved coterie of craftsmen, the men in the maintenance of equipment department. Why this is true is hard to say, but the most plausible explanation is that there is a lack of inducement. The average craftsman has no desire to rise from the ranks, whereas, just a few years back, just as soon as a mechanic finished his time he set as his next goal a foremanship and so on up the line. Why should they so suddenly be content to hold their jobs as mechanics? There are hundreds of instances where men have refused promotion and the statement is made every day that it is almost impossible to fill minor supervisory positions. The men seem to reason it out about as follows: As a mechanic I work eight hours, go home to my family in a state of mind that enables me to forget railroading for sixteen hours. This spare time can be used very profitably in making extra money or in some form of recreation and my goal is to enter business for myself some time or to prepare myself for a different line of work where the opportunities are greater. A job on the side breaks the monotony, is better for my body and mind than loafing or play and is really a recreation to me. As a foreman I would have to work ten or twelve hours per day for a salary that would give me less per hour worked than my present rate; would have to do practically two days' work as compared with the old times, as there are two shifts to start to work and getting started promptly and properly is a big part of the foreman's day's work. The work is so divided among the craftsmen that a foreman has to exert much more energy in getting a job done than heretofore; in other words, it requires closer supervision. Conditions do not permit the close supervision required, consequently more mistakes are made, the foreman is held responsible and it is necessary therefore to be big enough and so constituted that he can stand any amount of "bull ragging" from above. From below the lines are marked with chalk and he dare not overstep or the "Committee" will get his job. If promotion comes it simply means that the responsibilities and "bull ragging" are increased. There are so many instances where men have had five-ten-twenty-five years cut off of their lives by the excessive responsibility and so very few who were able to save a competence and retire from the business in time, that we must think twice before starting up the ladder. There is little assurance of permanency, as a thousand and one things beyond my reach, but supposed to be directly in my control, may cost my job in a day, whereas, as a mechanic, we can not be fired without just cause.

4th—The minor officials complain of insufficient men, inefficiency of men, handicaps imposed by reason of the National Agreement, the independence of the men and their quick retaliation for any mistake or infringement on what they call their rights. These men do the best they can, they say, but this is not good enough, and the higher officials are always asking for better results. They do not kick much in their own behalf, they do not size up the proposition completely, they are resigned to their fate, so do the best they can and stand the brunt.

It is obvious that these minor officials are doing at least one-third more work than formerly, and an enginehouse foreman's job was never considered a cinch or anything approaching a cinch. They are either working one-third more men or are doing as much work with one-third less men, have two sets of men to handle on their one shift, instead of the former one set, are unable to exercise as strict discipline as formerly, and are required to do things in a new way under the new regulations.

The question of pay day does not enter into these men's jobs, as plenty of good men could be secured at present salaries if their working hours were better and if conditions would permit them to actually accomplish what is expected of them, as this would mean there was some real satisfaction in handling the job. As it is, more is expected than it is humanly possible to give, the best they can do is not good enough and ten or twelve hours a day, besides time getting to and from work, does not leave much reserve for spurts or for calm thinking, planning and executing.

There has been more comment in the last few months on an article in a mechanical paper depicting the predicament the Supt. of M. P. got into in undertaking to personally handle an enginehouse foreman's job and "straighten things out," than on any other one subject. Why was this true? Simply because it put in print what they felt were the facts of their predicament and they also felt, no doubt, publicity would tend to alleviate their condition, although the arti-le in question offered no solution.

The question of reading is a very big one, but our excellent trade magazines do not o their full duty, for the subscribers do not read them enough. It is really surprising that you can hardly find one official in ten who has read, perhaps, the most important article published each month. It is not uncommon to see M. M. reading his mechanical paper on the train and a question will disclose the fact that he always carries one with him, as the only time he has to read is while riding over the division. Such a man, while utilizing all his time, can not keep as well informed or as alert as he would like or as he really should be to serve his company to the fullest extent.

5th—There is general complaint that apprentices are not as plentiful as they should be and that they lack, to some extent, stability and perseverance. This does not augur well for the future, as anyone will readily concede that the railroads absolutely *must* make a large number of men in the near future. There is not the same tendency for a man to have his son or relative enter the service. It would be interesting to know how many boys have started in the last two years on an apprenticeship, only to give it up in a short time. They look ahead and all they can see is a hard job. Lack of inducement is no doubt storing up trouble for the railroads by tending towards a potential shortage of mechanics. Contrast this with a few years ago when it was necessary for a boy to have a certain amount of "pull" and a pretty good reputation to get him started on an apprenticeship.

There is no benefit in pointing out existing evils unless there is a remedy, so let's start something and see if, all together, we cannot devise a scheme that will put the old and a better new zest and fascination into the railroad game and start things humming.

1st—Get a sufficient number of men. You say they are not available. Perfect some arrangement whereby machine men or the men that are available can be given an intensive course of instruction for not over 30 days, as there is a rule that men must be given a fair chance to make good. Much can be done in the way of assigning particular men to particular work, specializing, if you please There are men being fired today with such explanations as "We want machinists and can not afford to pay you eighty-five cents per hour if you do not know how to close a front end main rod brass." There are men available today who have the required fundamental experience, but are being turned away because no one has time to assist or instruct them. This is the height of foolishness when you really need men and the right kind are not available. Look how many greenhorns learned to drill and shoot in such short order. Moving pictures could teach a class in a few minutes a number of the routine jobs that come up in the maintenance of a locomotive, or a foreman could be put in charge of a gang of six to ten new men and give them instructions that would enable them to compete with the older men in short order. A large number of such men would feel under obligations to some extent and would undoubtedly be of great assistance in maintaining power.

2nd—Every enginehouse should have sufficient supervisory forces so that they would have to work not more than nine hours, if necessary having three assistant master mechanics, three general foremen and so on. These nine-hour shifts will double the supervision at change of the eight-hour workmen's shifts, which will certainly tend towards better results. It seems the eight-hour day has come to stay, and it has been proven that a man can produce as much in eight hours as he can in ten, but it takes closer supervision, not driving, but planning. On the piece work or bonus system the man himself did the planning in order to accomplish more by having just the right tools or in studying out little kinks or strategies that would speed up the operation. There is no inducement to the workman now; he earns no more and he does not crave promotion, as the job ahead does not appeal to him. Supervision must plan for him and see that the plans are executed. This in time will make the official's job one to be desired, the workmen will take more pride in their work and strive to excel in order to gain promotion.

One-half of the engine failures are preventable, maintenance costs are at least 20% too high on account of poor design, delay in repairs, poor workmanship and lax inspection. It takes the supply man to figure out what is being lost through the use of antiquated equipment, tools or appliances. Give the responsible officials time to study such matters and wonderful results will be obtained. There is so much that can be accomplished without expenditure, and when we accomplish some of these the "big guns" will no doubt loosen up and listen to some of our plans that call for expenditures.

The average M. M., we will say, receives $540 per month and ranks high in the community as far as salary is concerned. How often does he attend church or play a game of golf with his lawyer friend, take a hunt with his merchant or spend a few hours at the club with his banker? He should have a mental capacity equal to these men, but he is so absorbed with detail that the best he can do is to eat three meals a day at home and have eight hours left for intercourse with his family, for recreation and sleep. Our officials are overworked and they are stale; nay, numb. Give them a chance and they will straighten things out in a jiffy. Something must be done. The chief inspector of locomotives of the I. C. C., in his last report shows 59,772 locomotives inspected, 34,557 in defective condition, 4,433 ordered out of service for being operated in violation of Federal laws, 565 accidents, 57 killed, 647 injured. Federal laws covering all this have been in effect since 1912 and 1916. Why this apparent willful violation of these laws? Compliance, we hear on every hand, is economical and our own experience proves it. Is it not due to lack of the proper efficiency in our M. of E. Depts., which is caused by everyone above the mechanic being called upon to assume more responsibility and attend to more detail than he can handle efficiently?

Wheel Guard for Railroads.

It is reported that a number of mechanical railroad men in Northern Ohio recently tested a new rail guard which is attached to the front end of cars and extends to within a few inches of the rails. All tests were made with a dummy weighing as near as possible the average weight of men employed as brakemen, switchmen and in other railroad capacities. In all tests at which time the dummy was placed in positions resulting from falls from moving trains, the guard cleared the track of the obstacle, and in only one was it injured. This was in a case in which the dummy sat upon the tracks and was passed under the train between the wheels, uninjured with the exception of having its overalls torn and scratched.

The guard itself is a forged bar of steel curved to conform to the shape of a car wheel. The upper end is T-shaped which provides means for bolting it to the carbolts of the underframe. The lower end holds a slipper. Normally this balances, but when an object is forced against it, it drops to the track and clears off any obstruction. It will not only be the means of saving lives of railroad men, but will prevent train wrecks.

Electrical Department

Maintenance of Railway Apparatus--Controller Fingers and Contacts—Advantages of Dipping and Baking Electric Motors—The Automatic Substation

Generally when one refers to control apparatus for railway work we think of contractors in unit switches which are closed together either by air pressure electrically controlled and known as electro-pneumatic switches or by the magnetic pull of a coil with electric current flowing through it and known as magnetic switches. Both types have been described before in these pages. There is another method used to make contacts for the carrying of the electric current than the above, and an arrangement that is used almost universally on small street railway equipments and frequently in heavy equipments. The arrangement referred to, is the application of a finger to a copper contact mounted on a drum. The drum revolves and the fingers make and break contact. The general practice is to use the fingers so that the circuit is made only and the current flows. When the current is to be interrupted a unit switch opens. This is better than to break the heavy currents on the drum.

In order to carry the current without burning or heating the fingers must bear with a certain pressure against the contacts. Naturally there is friction. There are therefore two essentials to the satisfactory and economical operation of this type of control apparatus, i. e., contact pressure and lubrication. In almost every railroad shop there is electric apparatus and in many of the very large ones electric drive is used quite extensively. Drum controllers are used to start up the motors so that the principle of the drum and finger arrangement is rather common. It is important, however, that the proper attention be given the apparatus and we have gone into considerable details as to the maintenance of the fingers and contacts.

Fingers are made of various widths and sizes depending on the amount of current that is to be carried. What is known as a large capacity finger is three-quarters to one inch in width and is the size used in many of the larger controllers. The fingers and segments or contacts are both of copper. Copper is relatively soft so that the wear will be excessive unless properly lubricated. Also both finger and contact being of the same composition the wear tends to be more rapid than unlike metals. The quality of the lubricant to be used varies with the climate and temperature. Vaseline is satisfactory for summer and for moderate winters while engine oil is the most satisfactory for very cold temperature.

Too much lubricant can be used here as in many other cases. It is erroneous to suppose a large quantity is needed. Any surplus soon wipes off, accumulates in the arcing barriers, drum, etc., and collects copper dust and dirt, with the result that failure is more apt to occur. The best practice is to spread the lubricant as smoothly over the segment as possible, operate the fingers over the segment several times and then wipe off the surplus around the finger and segment.

The above is primarily for fingers which do arc and break current. Where non-arcing duty is only performed, less lubricant is required and should be of lighter grade.

Many times the fingers will become roughened and pitted, also the end of the segment where contact with the finger is made and broken. This condition should be looked for and the fingers and segments smoothed with a file or emery paper before the lubrication is applied.

The safe current which can be carried on a finger depends on four things—the width of the contact surface, the pressure on the finger at the point of contact, the radiation of the finger and the mass and radiation of the segment. The capacity for a given width depends on the pressure, the heavier the pressure the greater the capacity. Too heavy a pressure results in excessive wear and stiff drums and instead of using excessive pressure to give carrying capacity a wide finger is used.

The average pressure is as follows: Where copper is used for both finger and segment. For the one-inch finger a pressure of 8 lbs.; for a three-quarter inch finger a pressure of 6 lbs.; for a one-half inch finger a pressure of 4 lbs.; for a one-quarter inch finger a pressure of 2 lbs.

In measuring the pressure a spring balance is used, a stirrup of wire being used to fit the finger.

Dipping and Baking.

It has only been during the last few years that the dipping and baking of motor armatures has been extensively carried on. It was the practice to insulate the coils in the best possible manner and dip and bake them; then wind the armature and put into service. Motors are subjected, in many instances, to very severe service and must run under conditions of dirt and moisture.

Dipping the complete armature in an insulating varnish after the armature has been wound, and baking in ovens until the varnish is hard has been very effective in eliminating the trouble so easily caused by snow and water. Railway motors are subjected, especially, to the moisture and dipping and baking has been most beneficial. The Westinghouse Electric & Mfg. Company have gone into this matter very thoroughly. Not only have they provided extensive ovens for baking in their own factory, but they have designed and sell ovens which are electrically heated and automatically regulated so that any railroad shop can erect and use.

Dipping and baking need not be applied entirely to newly wound motors. If a dipping and baking treatment is given motors which have been in service, a renewed life will be given the insulation. The varnish will close up cracks and pores and will present a smooth and clean surface that is not harmed by dirt and moisture. The advantages gained by dipping and baking the whole piece are: The coils are held in place in the slot securely and therefore are less subject to vibration; all the cracks are sealed, preventing the deposit of dirt and moisture; the loose laminations are sealed and vibration prevented; a coating is formed over the iron which prevents rust; the insulation of any coil which may have been bruised in handling during winding and assembling, is restored to good condition.

The Automatic Substation.

A very interesting development in the electrical art is that of the automatic substation. Electric power is generated in a power house and transmitted to substations and from these substations fed to the overhead wires or third rail. In the case of a direct current system the alternating current is converted over to direct current for the trolley, by rotating machines, known as rotary converters. With the ordinary control, considerable attention must be given by the attendants. The machines must be started and regulated.

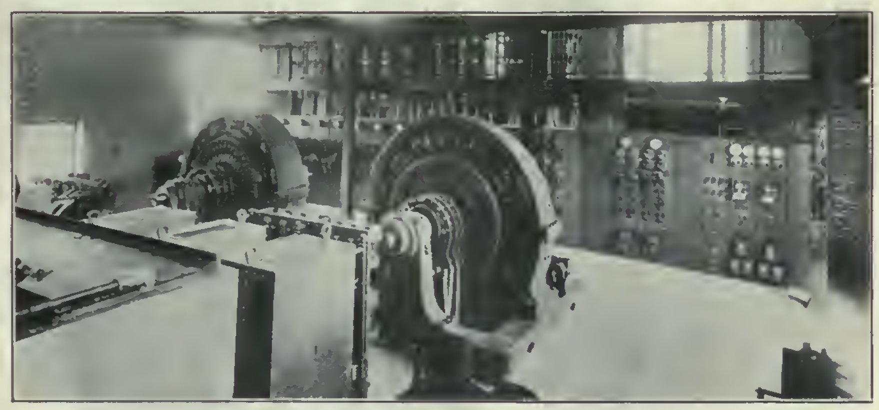
Rotary converters must be cut in and out of service as the load demand increases or decreases.

The automatic features eliminate the

attendants and all of the functions take place automatically and at just the right time.

The illustration shows the rotary converters just installed by the Cleveland Railway Company. There are two 1500 kw. units in the substation and they are about the size which would be necessary to furnish direct current energy for electric locomotives and multiple unit motor cars on steam lines. This installation is interesting, for when automatic substations were first installed several years ago to take care of small loads, little thought was then given that "laborless" equipment could be used where larger units were installed and heavy service was to be taken care of.

The two 1500 kw. Westinghouse rotary-converters in this station are each equipped with the proper circuit-breaker, transformer and automatic control equipment. Although the station does not carry a load continuously at least one of the units will be operated from about 4 a. m. until midnight. This machine will be placed on the line automatically when the cars in its district start running and the trolley voltage drops below normal. After this happens it will take the unit about 40 seconds to get started and convert energy for the transportation system. It will continue to take care of the load until the time arrives when it will carry full load for about 15 minutes. At this time, the second machine will be started automatically to take its share of the load. This will carry the load through the morning peak, the second machine continuing to operate until it carries only 50 per cent of normal load. Fifteen minutes after this point is reached, the second machine will shut down, leaving the first machine to supply the energy for the day load. Then, when the evening load comes on and goes off the second machine will be started and stopped to meet the conditions. At midnight when the cars stop running the first machine will shut down automatically. Besides taking care of varying conditions, precautions have been taken to meet all difficulties that can be foreseen. For this purpose there are eighteen protective relays, each one functioning as conditions for its use arise.



LARGE ROTARY CONVERTERS OPERATED AUTOMATICALLY WITHOUT THE SERVICE OF ATTENDANTS.

The Prospects of Railroad Electrification in America and Abroad

F. H. Shepard, Director of Heavy Traction, Westinghouse Electric & Mfg. Company

The world-wide shortage of coal during the great war has emphasized more clearly than ever the necessity of fuel economy in industry, while the present shortage of labor and the certainty of its continuing scarcity throughout the reconstruction period forms another most serious problem. But fortunately we have at our disposal a means that will greatly assist in alleviating both of these conditions, namely—electrification.

The use of electricity in industry saves both fuel and labor. This fact is recognized throughout the world today, and in order to secure these advantages, practically all of the nations are now considering plans for the electric generation of power. In England, Belgium and France, among other, these plans are being prepared by official commissions, so that a tremendous activity in electrical power development may be expected with the stabilization following the advent of peace. In all cases, the ideal in view is a broad one: To use electricity for all possible power purposes, including railroad operation.

The operation of the railroads will naturally form an important part of any program of general electrification, for in almost every country the railroads form one of the largest users of fuel and labor. Nor are the advantages obtained from railroad electrification limited solely to economy in fuel consumption and the more effective use of labor. Among others, the following can be mentioned:

1. Greater speed of movement for the heaviest trains, due to the fact that electric locomotives can be made much more powerful than the largest steam locomotives.

2. Greater nicety of control.

3. Increased traffic capacity of existing tracks, terminals, grades, tunnels, and other points of traffic restriction, because when electricity is used, heavier trains can be operated at higher speeds and less time is consumed at terminals and in yards.

4. Operation where the use of steam is impossible or objectionable, as in long tunnels.

5. Independence of weather conditions, since the electric locomotive is not affected by cold weather.

6. More reliable operation, as proved by the statistics of all existing electrifications.

7. More effective use of all rolling stock, due to more expeditious movement of traffic.

8. These are some of the advantages that are now being obtained for the mere substitution of the electric locomotive for the steam locomotive, but they by no means tell the whole story.

Consider electric illumination. When first introduced, the electric lamp supplanted a gas or an oil light because of certain advantages it possessed, and at first it occurred to no one that it would ever do much more. But the electric lamp has within thirty years revolutionized illumination and has given us our light-flooded factories, with their greatly increased production and safety.

The industrial electric motor is another case in point. At first it merely took the place of a steam engine in the factory. Today, practically every machine has its own motor of specially selected characteristics, and feats of production are now possible that were undreamed of a generation ago.

A further example is the growth of our great city and interurban electric transportation service of today from the substitution of the electric motor for the horse on street cars.

In other words, an electrical method will in the beginning take the place of an older practice because of some economic superiority. Then, its almost unlimited inherent possibilities are developed and in time results are accomplished that would be impossible at any cost with the older methods.

There is good reason to expect that the electric operation of the railroads is ca-

275-TON PASSENGER LOCOMOTIVE—CHICAGO, MILWAUKEE & ST. PAUL RAILROAD.

pable of a similar development and will in time revolutionize our present transportation methods and provide us with services we know little or nothing about today.

CONDITIONS IN THE UNITED STATES.

Since the United States has an abundance of coal, railroad electrification here has been determined solely by local conditions. Passenger terminal problems caused the electrification of the New York Central at New York and the Pennsylvania at New York and Philadelphia. The limitations of the steam locomotive determined the electrification of the Baltimore Tunnel on the Baltimore & Ohio, the Cascade Tunnel on the Great Northern, the St. Clair Tunnel on the Grand Trunk, the Hoosac Tunnel on the Boston & Maine and the Detroit River Tunnel on the Michigan Central. Examples of electrified railroads with freight as well as passenger service are the Norfolk & Western, the Chicago, Milwaukee & St. Paul and the New York, New Haven & Hartford.

While the other electrifications are successful and interesting, the last three are more properly representative of general railroad electrification. The Norfolk & Western is an example of electrification under the heaviest conditions of freight traffic on a mountain grade. The Chicago, Milwaukee & St. Paul has in operation the longest continuous mileage in the world, and when completed will cross five mountain ranges. The New York, New Haven & Hartford has a very large movement of both freight and passenger traffic. All three installations are successful and profitable and, when financial conditions are stabilized and the American railroad question settled, it is expected that all three will extend their electrified service.

In addition there are sections of railroads about the country where the present congestion of traffic or the availability of water-power warrants the early adoption of electric power. These possibilities alone promise under normal conditions of finance (as no engineering problems now

180-TON PASSENGER LOCOMOTIVE—NEW YORK, NEW HAVEN & HARTFORD R. R.

remain to be solved) extensive activity in the electrification of railroads for many years to come.

CONDITIONS ABROAD.

Differing from America, European and South American countries, with the exception of England alone, lack an adequate supply of fuel, but many of them, including Norway, Sweden, Switzerland, Italy, Spain and Brazil, have large amounts of water power, while France has a moderate amount. These resources combined with the high cost of fuel make extensive railroad electrification in these countries inevitable sooner or later.

The neutral countries will probably be the first to undertake this work, Switzerland having a program covering a term of years well established, while both Norway and Sweden are giving active consideration to definite projects. In England, a considerable amount of electrification is in contemplation along with the general plan for the electrification of industry. A French Commission, composed of government and railroad engineers, have already visited the United States in order to thoroughly familiarize themselves with American practice. The Italian Government will continue their definite program as soon as financial conditions permit. An official Belgian Commission is already planning to rehabilitate with electric power at least a portion of the railroads destroyed by the Germans. In Spain and Brazil railroad electrification is under active consideration.

Railway Electrification in South Africa.

Electrical engineers were brought out from England and presented a report to Parliament recommending extensive electrification of suburban railway service at Cape Town, Johannesburg, and in the coal and gold mining areas of Transvaal and Natal. Large capital expenditures will be needed in the near future upon new railroad lines, as well as for existing lines and increasing rolling stock to meet the growing demands of traffic. Meanwhile the sum of $48,665 has been appropriated for electrification of a portion of the main line between Durban and Gleneve Junction in Natal.

American Railroad Association

Officers, General and Special Committees, Section III—Mechanical

At a meeting of the General Committee, the standing and special committees to serve until June, 1921, were appointed. The committees have been given alphabetical designations as well as names. Those committees having a number after the designating letter are considered as part of the committee whose letter they bear, and the chairmen of such committees will be expected to attend meetings of main committee.

The officers and committees of Section III—Mechanical, consist of the following:

Officers:—W. J. Tollerton, Chairman; J. Coleman, Vice-Chairman; V. R. Hawthorne, Secretary, 431 South Dearborn Street, Chicago.

GENERAL COMMITTEE.

W. J. Tollerton, Chairman, General Mech. Supt., C. R. I. & P. Ry. James Coleman, Vice-Chairman, Assistant to General Supt. Motive Power and Car Dept., G. T. Ry. System; C. F. Giles, Supt. Machinery, L. & N. R.R.; T. H. Goodnow, Supt. Car Dept., C. & N. W.; A. Kearney, Supt. Motive Power, N. & W. Ry.; J. E. O'Brien, Mech. Supt., M. P. R.R.; J T. Wallis, Chief of Motive Power, Penn. System; W. H. Winterrowd, Chief Mech. Engineer, C. Pacific Ry.; C. E. Chambers, Supt. Motive Power and Equipment, C. R.R. of N. J.; J. S. Lentz, Master Car Builder, L. V. R.R.; C. E. Fuller, Supt. Motive Power and Machinery, U. P. R.R.; H. L. Ingersoll, Assistant to President, N. Y. C. R.R.; John Purcell, Assistant to Vice President, A. T. & S. Fe Ry.; J. J. Tatum, Supt. Car Dept., B. & O. R.R.; Willard Kells, General Supt. Motive Power, A. C. L. R.R.; Wm. Schlafge, Mech. Manager, E. R.R.

STANDING COMMITTEES.

A—ARBITRATION.

T. H. Goodnow, Chairman, Supt. Car Dept., C. & N. W. Ry.; J. J. Hennessey, Assistant Master Car Builder, C. M. & St. P. R.R.; J. Coleman, Assistant to General Supt. Motive Power and Car Department, G. T. Ry.; F. W. Brazier, Assistant to General Supt. Rolling Stock, N. Y. C. R.R.; T. W. Demarest, General Supt. Motive Power, Penn. System; J. E. O'Brien, Mech. Supt., M. P. R.R.; G. F. Laughlin, General Supt., Armour Car Lines, Chicago, Ill.

A-1—Prices for Labor and Material.

A. E. Calkins, Chairman, Supt. Rolling Stock, N. Y. C. R.R.; Ira Everett, Chief Car Inspector, L. V. R.R.; J. H. Milton, Supt. Car Dept., C. R. I. & P. R.R.; C. N. Swanson, Supt. Car Shops, A., T. & S. Fe Ry.; T. J. Boring, General Foreman M. C. B. Clearing House, Penn. System, Altoona, Penn.; E. H. Weigman, Inspector M. C. B. Work, L. & N. R.R.; I. N. Clark, Master Car Builder, G. T. Ry., London, Ont.; H. G. Griffin, General Supt. Shops, Morris & Company, Chicago, Ill.; A. E. Smith, Master Car Builder, Union Tank Car Company, New York, N. Y.

B—ARRANGEMENTS.

W. J. Tollerton, chairman, General Mech. Supt., C., R. I. & P. Ry; J. Coleman, Assistant to General Supt. Motive Power and Car Department, G. T. Ry; J. F. Schurch, Vice-President, the T. H. Symington Co., Chicago.

C—AUTOGENOUS AND ELECTRIC WELDING.

J. T. Wallis, Chairman, Chief of Motive Power, Penn. System; G. W. Rink, Assistant Supt. Motive Power, C. R.R. of N. J.; A. M. McGill, Assistant Supt. Motive Power, L. V. R.R.; R. W. Schulze, Supt. Car Dept, St. L.-S. F. Ry.; Willard Kells, General Supt. Motive Power, A. C. L. Ry.; H. T. Bentley, Supt. Motive Power and Machinery, C. & N. W. Ry.; T. P. Madden, Traveling Boiler Inspector, M. P. R.R.; H. B. MacFarland, Engineer Tests, A., T. & S. F. Ry.; G. M. Gray, Supt. Motive Power, B. & L. E. R.R.; H. Wanamaker, District Supt. Motive Power, N. Y. C. R.R., West Albany, N. Y.; J. T. Carroll, General Supt. Motive Power, B. & O. R.R.

D—CAR CONSTRUCTION.

W. F. Kiesel, Jr., Chairman, Mech. Engineer, Penn. System, Altoona, Penn.; A. R. Ayers, Supt. Motive Power, N. Y., C. & St. L. R.R., Cleveland, Ohio; C. E. Fuller, Supt. Motive Power and Machinery, U. P. R.R., Omaha, Neb.; J. C. Fritts, Master Car Builder, D., L. & W. R.R., Scranton, Penn.; C. L. Meister, Mech. Engineer, A. C. L. R.R., Wilmington, N. C.; W. J. Robider, General Master Car Builder, C. P. Ry., Montreal, Can.; J. McMullen, Supt. Car Dept., E. R.R., New York City; T. H. Goodnow, Supt. Car Dept., C. & N. W. Ry., Chicago, Ill.; C. C. Higgins, Supt. Motive Power, St. L.-S. F. Ry., Springfield, Mo.; John Purcell, Assistant to Vice-President, A., T. & S. F.; W. O. Moody, Mech. Engineer, I. C. R.R., Chicago, Ill.; J. A. Pilcher, Mech. Engineer, N. & W. Ry., Roanoke, Va.; H. L. Ingersoll, Assistant to President, N. Y. C. R.R.; W. H. Wilson, Assistant to Vice-President, N. P. Ry.; F. W. Mahl, Director of Purchases, S. P. Co., New York, N. Y.

D-1—Brake Shoe and Brake Beam Equipment.

W. J. Bohan, Chairman, Assistant General Mech. Supt. N. P. Ry., St. Paul, Minn.; C. B. Young, Mech. Engineer, C., B. & Q. R.R., Chicago, Ill.; F. M. Waring, Engineer Tests, Penn. System, Altoona, Penn.; M. H. Haig, Mech. Engineer, A., T. & S. F., Topeka, Kan.; H. W. Coddington, Engineer Tests, N. & W. Ry., Roanoke, Va.; G. E. Smart, General Master Car Builder, C. N. Rys., Toronto, Ont.; T. L. Burton, Consulting Air Brake Engineer, N. Y. C. R.R., New York, N. Y.; C. H. Benjamin, Dean, Purdue University, Lafayette, Ind.

D-2—Couplers and Draft Gears.

R. L. Kleine, Chairman, Assistant Chief of Motive Power, Penn. System; J. C. Fritts, Master Car Builder, D., L. & W. R.R., Scranton, Penn.; J. R. Onderdonk, Engineer Tests, B. & O. R.R., Baltimore, Md.; J. A. Pilcher, Mech. Engineer, N. & W. Ry., Roanoke, Va.; C. B. Young, Mech. Engineer, C., B. & Q. R.R., Chicago, Ill.; L. K. Sillcox, General Supt. Motive Power, C., M. & St. P. R.R.; C. Brady, Engineer Car Construction, C. P. R.R., Montreal, Can.; A. H. Fetters, Mech. Engineer, U. P. R.R., Omaha, Neb.; Samuel Lynn, Master Car Builder, P. & L. E. R.R., McKees Rocks, Pa.; Prof. L. E. Endsley, University of Pittsburgh, Pittsburgh, Penn.

D-3—Train Brake and Signal Equipment.

T. L. Burton, Chairman, Consulting Air Brake Engineer, N. Y. C. R.R., New York, N. Y.; B. P. Flory, Supt. Motive Power, N. Y., O. & W. Ry.; J. M. Henry, General Supt. Motive Power, Penn. System, Phila., Penn.; L. P. Streeter, Air Brake Engineer, I. C. R.R., Chicago, Ill.; R. B. Rasbridge, Supt. Car Dept., P. & R. Ry., Reading, Penn.; G. H. Wood, General Air Brake Instructor, A., T. & S. F. Ry.; H. M. Curry, General Mech. Supt. N. P. Ry.; W. J. Hatch, General Air Brake Inspector, C. P. Ry., Montreal, Can.; G. C. Bishop, Supt. Motive Power, L. I. R.R.

E—CAR WHEELS.

W. C. A. Henry, Chairman, General Supt. Motive Power, Penn. System, St. Louis, Mo.; W. H. Winterrowd, Chief Mech. Engineer, C. P. Ry.; J. A. Pilcher, Mech. Engineer, N. & W. Ry., Roanoke, Va.; O. C. Cromwell, Assistant to General Supt. Motive Power, B. & O. R.R., Baltimore, Md.; C. T. Ripley, General Mech. Inspector, A., T. & S. F. Ry., Chicago, Ill.; H. Stillman, Mech. Engineer and Engineer Tests, S. P. R.R., San Francisco, Calif.; L. K. Sillcox, General Supt. Motive Power, C., M. & St. P. R.R.; H. C. Manchester, Supt. Motive Power and Equipment, D., L. & W. R.R.; P. H.

Dudley, Consulting Engineer, N. Y. C. R.R., New York, N. Y.

F—COMMITTEES.

T. H. Goodnow, Chairman, Supt. Car Department, C. & N. W. R.R., Chicago, Ill.; J. S. Lentz, Master Car Builder, L. V. R.R.; C. F. Giles, Supt. Machinery, L. & N. R.R., Louisville, Ken.; J. E. O'Brien, Mech. Supt., M. P. R.R., St. Louis, Mo.; J. T. Wallis, Chief of Motive Power, Penn. R.R.

G—LOCOMOTIVE CONSTRUCTION.

H. T. Bentley, Chairman, Supt. Motive Power and Machinery, C. & N. W. Ry.; H. C. Oviatt, Supt. Motive Power, N. Y., N. H. & H. R.R.; C. E. Fuller, Supt. Motive Power and Machinery, U. P. R.R.; F H. Hardin, Chief Engineer of Motive Power and Rolling Stock, N. Y. C. R.R., New York, N. Y.; H. M. Curry, General Mech. Supt., N. P. Ry.; P. F. Smith, Jr., Works Manager, Penn. System, Altoona, Penn.; E. C Chenoweth, Mech. Engineer, C., R. I. and P. Ry., Chicago, Ill.; M. F. Cox, Mech. Engineer, L. and N. Ry., Louisville, Ken.; W. I. Cantley, Mech. Engineer, L. V. Ry., Bethlehem, Penn.; G. H. Emerson, Chief of Motive Power and Equipment, B. & O. R.R.; W. H. Winterrowd, Chief Mech. Engineer, C. P. Ry.

G-1—Design and Maintenance of Locomotive Boilers.

G. H. Emerson, Chairman, Chief of Motive Power and Equipment, B. & O. R.R.; C. B. Young, Mech. Engineer, C., B. & Q. R.R., Chicago, Ill.; A. W. Gibbs, Chief Mech. Engineer, Penn. System; Jos. Chidley, Supt. Motive Power, N. Y. C. R.R., Cleveland, Ohio; R. W. Bell, General Supt. Motive Power, I. C. R.R., Chicago, Ill.; W. H. Wilson, Assistant to Vice-President, N. P. Ry.; W. W. Lemen, Supt. Motive Power and Car Department, D. & R. G. R.R.; R. J. Williams, Supt. Motive Power, P. M. Ry.; J. Snowden Bell, 149 Broadway, New York, N. Y.; George L. Bourne, President, Locomotive Superheater Co., 30 Church Street, New York, N. Y.

G-2—Feed Water Heaters for Locomotives.

F. M. Waring, Chairman, Engineer Tests, Penn. System, Altoona, Penn.; A. Kearney, Supt. Motive Power, N. & W. Roanoke, Virginia; W. H. Sample, General Supt. Motive Power and Car Department, G. T. Ry., Montreal, Can.; W. Kelly, General Supt. Motive Power, G. N. Ry., St. Paul, Minn.; G. W. Rink, Assistant Supt. Motive Power, C. R.R. of N. J., Jersey City, N. J.; L. P. Michael, Mech. Engineer, C. & N. W. Ry., Chicago; G. S. Edmonds, Supt. Motive Power, D. & H. Co., Watervliet, N. Y.

G-3—Fuel Economy and Smoke Prevention.

William Schlafge, Chairman, Mech. Manager, E. R.R., New York, N. Y.; D. J. Redding, Assistant Supt. Motive Power, P. & L. E. R.R., Pittsburgh, Penn.; W. J. Tollerton, General Mech. Supt., C. R. I. & P. R.R.; W. H. Sample, General Supt. Motive Power and Car Dept., G. T. Ry., Montreal, Can.; C H. Rae, Assistant Supt. Machinery, L. & N. R.R., Louisville, Ken.; H. A. Hoke, Assistant Mech. Engineer, Penn. System, Altoona, Penn.; E. B. Hall, Principal Assistant Supt. Motive Power and Machinery, C. & N. W. Ry., Chicago, Ill.

G-4—Mechanical Stokers.

M. A. Kinney, Chairman, Supt. Motive Power, H. V. Ry.; A. Kearney, Supt. Motive Power, N. & W. Ry.; A. J. Fries, Assistant Supt. Motive Power, N. Y. C. R.R., Depew, N. Y.; A. G. Trumbull, Mech. Supt., E. R.R., Youngstown, Ohio; F. W. Hankins, Assistant Chief of Motive Power, Penn. System, Philadelphia, Penn.; W. J. Bohan, Assistant General Mech. Supt., N. P. Ry., St. Paul, Minn.; H. C. Manchester, Supt. Motive Power and Equipment, D., L. & W. R.R.; W. Malthaner, Supt. Motive Power and Maintenance of Equipment, B. & O. R.R., Cincinnati, Ohio; M. H. Haig, Mech. Engineer, A., T. & S. F. Ry., Topeka, Kan.

H—LOADING RULES.

R. L. Klein, Chairman, Assistant Chief of Motive Power, Penn. System, Philadelphia, Penn.; J. J. Burch, General Foreman Car Dept., N. & W. Ry., Roanoke, Va.; E. J. Robertson, Supt. Car Dept., Soo Line, Minneapolis, Minn.; J. E. Mehan, General Car Foreman, C. M. & St. P. Ry., Milwaukee, Wis.; S. Lynn, Master Car Builder, P. & L. E. R.R., McKees Rocks, Penn.; Ira Everett, Chief Car Inspector, L. V. Ry., Bethlehem, Penn.; T. O. Sechrist, Assistant Supt. Machinery, L. & N. Ry., Louisville, Ken.; E. N. Harding, General Mech. Inspector, I. C. Ry., Chicago, Ill.; G. R. Lovejoy, Master Mechanic, Detroit Terminal R.R., Detroit, Mich.

I—MANUAL.

W. E. Dunham, Chairman, Assistant Supt. Motive Power and Machinery, C. & N. W. Ry., Chicago, Ill.; A. R. Ayers, Supt. Motive Power, N. Y., C. & St. L. R.R., Cleveland, Ohio; A. G. Trumbull, Mech. Supt., E. R.R., Youngstown, Ohio; W. F. Kiesel, Jr., Mech. Engineer, Penn. System, Altoona, Penn.; A. R. Kipp., Mech. Supt., Soo Line, Minn., Minn.; W. J. Robider, General Master Car Builder, C. P. Ry., Montreal, Can.; J. Hainen, Assistant to Vice-President, Southern Ry., Washington, D. C.; J. T. Carroll, General Supt. Motive Power, B. & O. R.R., Baltimore, Md.

J—NOMINATING.

F. W. Brazier, Chairman, Assistant to General Supt. Rolling Stock, N. Y. C. R.R.; H. T. Bentley, Supt. Motive Power and Machinery, C. & N. W. Ry.; J. J. Hennessey, Assistant Master Car Builder, C. M. & St. P. Ry.; C. E. Chambers, Supt. Motive Power and Equipment, C. R. of N. J.; William Schlafge, Mech. Manager, E. R.R.

K—SAFETY APPLIANCES.

C. E. Chambers, Chairman, Supt. Motive Power and Equipment, C. R.R. of N. J., Jersey City, N. J.; C. E. Fuller, Supt. Motive Power and Machinery, U. P. R.R., Omaha, Neb.; W. J. Tollerton, General Mech. Supt., C., R. I. & P. R.R., Chicago; J. T. Wallis, Chief of Motive Power, P. System, Philadelphia, Penn.; C. F. Giles, Supt. Machinery, L. & N. Ry., Louisville, Ken.; T. H. Goodnow, Supt. Car Dept., C. & N. W Ry., Chicago, Ill.

L—SPECIFICATIONS AND TESTS FOR MATERIALS.

F. M. Waring, Chairman, Engineer Tests, Penn. System, Altoona, Penn.; J. R. Onderdonk, Engineer Tests, B. & O. R.R., Baltimore, Md.; Frank Zeleny, Engineer Tests, C., B. & Q. Ry., Aurora, Ill.; A. H. Fetters, Mech. Engineer, U. P. R.R., Omaha, Neb.; H. B. MacFarland, Engineer Tests, A., T. & S. F. Ry., Chicago, Ill.; H. G. Burnham, Engineer Tests, N. P. Ry., St. Paul, Minn.; H. E. Smith, Materials Engineer and Chemist, N. Y. C. R.R., New York, N. Y.; J. C. Ramage, Supt. Tests, Southern Ry., Alexandria, Va.; J. H. Gibboney, Chemist, N. & W. Ry., Roanoke, Va.; H. P. Hass, Engineer Tests, N. Y., N. H. & H. R.R., New Haven, Conn.; K. F. Nystrom, Engineer Car Construction, G. T. Ry., Montreal, Can.

M—SUBJECTS.

Willard Kells, Chairman, General Supt. Motive Power, A. C. L. R.R., Wilmington, N. C.; W. H. Sample, General Supt. Motive Power and Car Department, G. T. Ry., Montreal, Can.; H. M. Curry, General Mech. Supt., N. P. Ry., St. Paul, Minn.; William Schlafge, Mech Manager, E. R.R., New York, N. Y.; F. W. Brazier, Assistant to General Supt. Rolling Stock, N. Y. C. R.R., New York, N. Y.

N—TANK CARS.

A. W. Gibbs, Chairman, Chief Mech. Engineer, Penn. System, Phila., Penn.; C. E. Chambers, Supt. Motive Power and Equipment, C. R.R. of N. J., Jersey City, N. J.; A. G. Trumbull, Mech. Supt., E. R.R., Youngstown, Ohio; S. Lynn, Master Car Builder, P. & L. E. Ry., McKees Rocks, Penn.; John Purcell, Assistant to Vice-President, A., T. & S. F. Ry., Chicago, Ill.; George McCormick, General Supt. Motive Power, S. P. Ry., San Francisco, Cal.; F. K. Tutt, Mech. Supt., M., K. & T. Ry., Denison, Texas; Col. B. W. Dunn, Chief Inspector, Bureau of Explosives, 30 Vesey street, New York, N.Y.; A. E. Smith, Master Car Builder, Union Tank Car Co., 21 East Fortieth street, New York, N. Y.; George Hartley, care of Semet-Solvay Company, Syracuse, New York; C. W. Owsley, Chief Inspector, The Texas Company, 90 West street, New York, N. Y.

SPECIAL COMMITTEES.

O—AMALGAMATION OF OTHER MECHANICAL ORGANIZATIONS WITH SECTION III—MECHANICAL, OF THE AMERICAN RAILROAD ASSOCIATION.

W. O. Thompson, Chairman, General Supt. Rolling Stock, N. Y. C. R.R., Buffalo, New York; T. L. Burton, Consulting Air Brake Engineer, N. Y. C. R.R., New York, N. Y.; W. J. Tollerton, General Mech. Supt, C, R. I. & P. Ry., Chicago, Ill.; J. E. Fairbanks, General Secretary, A. R. A., New York City; V. R. Hawthorne, Secretary, Section III—Mechanical, A. R. A., Chicago.

P—CAR REPAIR SHOP LAYOUTS.

I. S. Downing, Chairman, General Master Car Builder, C., C., C. & St. L. Ry., Indianapolis, Ind.; George Thompson, Master Car Builder, N. Y. C. R.R., Collinwood, Ohio; J. J. Tatum, Supt. Car Dept., B. & O. R.R., Baltimore, Md.; C. W. Renner, Assistant General Foreman Car Shops, Penn System, Altoona, Penn.; W. J. Robider, General Master Car Builder, C. P. Ry., Montreal, Can.; J. C. Fritts, Master Car Builder, D., L. & W. Ry., Scranton, Penn; L. Robinson, Shop Engineer, I. C. R.R., Chicago, Ill.; C. N. Swanson, Supt. Car Shops, A. T. & S. F. Ry., Topeka, Kan.; E. P. Marsh, General Foreman Car Dept., C. & N. W. Ry., Chicago, Ill.; D. Wood, Assistant Mech. Engineer, S. P. Ry., San Francisco, Cal.

Q—DESIGN, MAINTENANCE AND OPERATION OF ELECTRIC ROLLING STOCK.

G. C. Bishop, Chairman, Supt. Motive Power, L. I. R.R., Richmond Hill, N. Y.; C. H. Quereau, Supt. Electric Equipment, N. Y. C. R.R., New York, N. Y.; W. L. Bean, Mech. Assistant, N. Y., N. H. & H. R.R., New Haven, Conn.; J. H. Davis, Electrical Engineer, B & O. R.R., Baltimore, Md.; George McCormick, General Supt. Motive Power, S. P. R.R., San Francisco, Cal.; J. A. Pilcher, Mech. Engineer, N. & W. Ry., Roanoke, Va.; J. V. B. Duer, Electrical Engineer, Penn System, Altoona, Penn.; John Dickson, Supt. Motive Power, S., P. & S. Ry., Portland, Ore.; L. K. Sillcox, General Supt. Motive Power, C., M. & St. P. R.R., Chicago, Ill.

R—ENGINE TERMINALS, DESIGN AND OPERATION.

C. E. Fuller, Chairman, Supt. Motive Power and Machinery, U. P. R.R., Omaha, Neb.; W. J. Tollerton, General Mech. Supt. C., R. I. & P. Ry., Chicago, Ill.; John Purcell, Assistant to Vice-President, A., T. & S. Fe. Ry., Chicago, Ill.; F. W. Hankins, Assistant Chief of Motive Power, Penn. System, Philadelphia, Penn.; C. F. Giles, Supt. Machinery, L. & N. R.R., Louisville, Ken.; H. H. Boyd, Assistant Chief Mech Engineer, C. P. Ry., Montreal, Can.; H. C. Eich, Supt. Motive Power, C., G. W. R.R., Oelwein, Iowa; G. F. Hess, Supt. Motive Power, Wabash Railway, Decatur, Ill.

S—LATERAL MOTION ON LOCOMOTIVES.

Willard Kells, Chairman, General Supt. Motive Power, A. C. L. R.R., Wilmington, N. C.; T. A. Foque, General Mech. Supt., Soo Line, Minneapolis, Minn; J. T. Carroll, General Supt. Motive Power, B. & O. Ry., Baltimore, Md.; R. W. Bell, General Supt. Motive Power, I. C. Ry., Chicago, Ill.; W. H. Sample, General Supt. Motive Power and Car Department, G. T. Ry., Montreal, Can.; H. T. Bentley, Supt. Motive Power and Machinery, C. & N. W. Ry.

T—LOCOMOTIVE HEADLIGHTS AND CLASSIFICATION LAMPS.

W. H. Flynn, Chairman, Supt. Motive Power, M. C. Ry., Detroit, Mich.; C. H. Rae, Assistant Supt. Machinery, L. & N. R.R., Louisville, Ken.; A. R. Ayers, Supt. Motive Power, N. Y., C. & St. L. R.R., Cleveland, Ohio; H. M. Curry, General Mech. Supt., N. P. Ry., St. Paul, Minn.; J. L. Minick, Assistant Engineer, Penn. System, Altoona, Penn.; E. W. Jansen, Electrical Engineer, I. C. Ry., Chicago, Ill.; R. W. Anderson, Supt. Motive Power, C., M. & St. P. Ry., Milwaukee, Wis.

U—MODERNIZATION OF STATIONARY BOILER PLANTS.

L. A. Richardson, Chairman, Mech. Supt., C., R. I. & P. Ry., Des Moines, Iowa; J. V. B. Duer, Electrical Engineer, Penn. System, Altoona, Penn.; J. H. Davis, Electrical Engineer, B. & O. Ry., Baltimore, Md.; L. C. Bowes, Supervisor Stationary Plants, C., R. I. & P. R.R., Chicago, Ill.; J. F. Raps, General Boiler Inspector, I. C. R.R., Chicago, Ill.; D. W. Cross, Supt. Motive Power, T., St. L. & W. Ry., Frankfort, Ind.; E. S. Pearce, Mech. Engineer, C., C., C. & St. L. R.R, Beech Grove,, Ind.

V—SCHEDULING OF EQUIPMENT THROUGH REPAIR SHOPS.

Henry Gardner, Chairman, Corporate Mech. Engineer, B. & O. Ry., Baltimore, Md.; D. J. Mullen, Supt. Motive Power, C., C., C. & St. L. R.R., Indianapolis, Ind.; P. F. Smith, Jr., Works Manager, Penn. System, Altoona, Penn.; John Purcell, Assistant to Vice-President, A., T. & S. F. Ry., Chicago, Ill.; C. J. Bodemer, Assistant Supt. Machinery, L. & N. R.R., Louisville, Ken.; E. C. Trotnow, Assistant Supt. Shops, N. Y. C. R.R., Collinwood, Ohio; C. Juneau, Master Car Builder, C., M. & St. P. R.R., Milwaukee, Wis.; G. W. Siedel, Supt. Motive Power and Equipment, C. & A. Ry., Bloomington, Ill.; J. J. Acker, General Foreman Car Dept., C., R. I. & P. R.R., 124th St. Shops, Blue Island, Ill.; E. T. Spidy, Production Engineer, C. P. Ry., Montreal, Can.

W—STANDARD BLOCKING FOR CRADLES OF CAR DUMPING MACHINES.

J. McMullen, Chairman, Supt. Car Department, E. R.R., New York, N. Y.; J. W. Senger, Supt. Rolling Stock, N. Y. C. R.R., Cleveland, Ohio.; J. J. Tatum, Supt. Car Dept., B. & O. R.R., Baltimore, Md.; J. E. Davis, Master Mechanic, H. V. Ry., Columbus, Ohio; G. M. Gray, Supt. Motive Power, B. & L. E. Ry., Greenville, Penn.; J. A. Pilcher, Mech. Engineer, N. & W. Ry., Roanoke, Va.; C. F. Thiele, Chief Car Inspector, Penn. System, Pittsburgh, Penn.

X—STANDARD METHOD OF PACKING JOURNAL BOXES.

C. J. Bodemer, Chairman, Assistant Supt. Machinery, L. & N. R.R., Louisville, Ken.; I. S. Downing, General Master Car Builder, C., C., C. & St. L. R.R., Indianapolis, Ind.; J. H. Milton, Supt. Car Dept., C., R. I. & P. Ry., Chicago, Ill.; J. P. Young, General Inspector Passenger Car Equipment, M. P. Ry., St. Louis, Miss.; G. W. Ditmore, Master Car Builder, D. & H. Co., Watervliet, N. Y.; L. R. Wink, Assistant Supt. Car Dept., C. & N. W. Ry., Chicago, Ill.; R. B. Rasbridge, Supt. Car Dept., P. & R. Ry., Reading, Penn.; W. C. Linder, Chief Car Inspector, Penn. System, Philadelphia, Penn.

Y—TRAIN LIGHTING AND EQUIPMENT.

J. R. Sloan, Chairman, Chief Electrician, Penn. System, Pittsburgh, Penn.; C. H. Quinn, Chief Electrical Engineer, N. & W. Ry., Roanoke, Va.; E. W. Jansen, Electrical Engineer, I. C. Ry., Chicago, Ill.; L. S. Billau, Assistant Electrical Engineer, B. & O. RR., Baltimore, Md.; A. J. Farrelly, Electrical Engineer, C. & N. W. Ry., Chicago, Ill.; H. A. Currie, Assistant Electrical Engineer, N. Y. C. R.R., New York, N. Y.; E. Wanamaker, Electrical Engineer, C., R. I. & P. Ry., Chicago, Ill.

Z—TRAIN RESISTANCE AND TONNAGE RATING.

O. P. Reese, Chairman, Supt. Motive Power, Penn. System, Toledo, Ohio; H. C. Manchester, Supt. Motive Power and Equipment, D., L. & W. Ry., Scranton, Penn.; Frank Zeleny, Engineer Tests, C., B. & Q. Ry., Aurora, Ill.; Joseph Chidley, Supt. Motive Power, N. Y. C. R.R., Cleveland, O.; W. E. Dunham, Assistant Supt. Motive Power and Machinery, C. & N. W. Ry., Chicago, Ill.; R. E. Jackson, Supt. Motive Power, Virginian, Ry., Princeton, W. Va.

Items of Personal Interest

R. J. Hoy has been appointed foreman of the Rock Island, with office at Wichita, Kan.

W. T. Hawkins has been appointed fuel agent of the Missouri Pacific, succeeding W. J. Roehl.

A. O. Sturdy has been appointed roundhouse foreman of the Rock Island, with office at Topeka, Kan.

R. R. Young has been appointed general foreman of the Ft. Smith & Western, with office at Weleetka, Okla.

Walter F. Kaiser has been appointed assistant roundhouse foreman of the Rock Island, with office at El Reno, Okla.

C. A. Bowers has been appointed master blacksmith of the Chicago & Northwestern, with office at Escanaba, Mich.

F. S. Gallagher has been appointed engineer of rolling stock of the New York Central, with headquarters at New York.

R. M. Brown has been appointed engineer of motive power of the New York Central, with headquarters at New York.

Willard Kell has been appointed superintendent of motive power of the Great Northern, with headquarters at St. Paul, Minn.

E. H. McCann has been appointed master mechanic of the eastern division of the Chicago Great Western, with headquarters at Stockton, Ill.

W. C. Livingston has been appointed division storekeeper of the Pittsburgh division of the Pennsylvania, with headquarters at Derry, Pa.

J. E. Stone has been appointed assistant master mechanic of the Salt Lake division of the Southern Pacific, with headquarters at Sparks, Nev.

Agnew T. Dice, Jr., railroad sales manager of the Reading Iron Company, Reading, Pa., has been placed in charge of the cut rail business of the company.

V. B. Story has been appointed general foreman of the Chicago, Rock Island & Pacific, with office at Amarillo, Tex., succeeding S. C. Thomas, resigned.

James Simpson has been appointed general master mechanic of the Northern Pacific Lines west of Paradise, Mont., with headquarters at Tacoma, Wash.

J. J. Melloy, master mechanic of the Missouri, Kansas & Texas, at Wichita Falls, Tex., has been transferred to Parsons, Kan., succeeding J. H. Henley.

J. H. Douglas, general shop foreman of the Wheeling & Lake Erie at Ironville, Ohio, has been promoted to master car builder, with headquarters at Brewster, Ohio.

V. A. Bennett has been appointed assistant bridge and building supervisor of the Montana division of the Northern Pacific, with headquarters at St. Paul, Minn.

J. H. Henley, master mechanic of the Missouri, Kansas & Texas, at Parsons, Kan., has been appointed road foreman of engines, with headquarters at Muskogee, Okla.

E. Modlin has been appointed chief dispatcher of the first and second districts of the Kansas City Southern, with headquarters at Pittsburg, Kan., succeeding F. H. Hooper.

C. A. Wirth has been appointed master mechanic of the Pasco division of the Northern Pacific, with headquarters at Pasco, Wash., succeeding G. F. Egbers, transferred.

E. L. Nutley has been appointed division master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Perry, Iowa, succeeding E. L. Emerson, transferred.

G. E. Doke, engineer of materials of the New York Central, with headquarters at Collinwood, Ohio, has been appointed engineer of tests with headquarters at New York.

L. E. Wingfield, master mechanic of the Arkansas Central, has resigned to accept an appointment as master mechanic of the Quanah, Acme & Pacific, at Quanah, Tex.

George W. Grossner has been appointed purchasing agent of the New Orleans Great Northern, with headquarters at New Orleans, La., succeeding W. Grentzenberg, resigned.

G. F. Egbers has been appointed master mechanic of the Idaho division of the Northern Pacific, with headquarters at Parkwater, Wash., succeeding James Simpson, promoted.

A. J. Williams, assistant road foreman of engines on the Maryland division of the Pennsylvania, has been appointed general air brake and steam heat inspector on the Southern division.

A. J. Lewis, shop superintendent of the Missouri, Kansas & Texas, at Denison, Tex., has been appointed master mechanic with the same headquarters, succeeding A. B. Corbett.

E. E. Stillwell, master mechanic of the Huarteca Oil Company, Tampico, Mexico, has resigned to accept the position of master mechanic of the Transcontinental Oil Company at Tampico.

T. N. Charles, signal and electrical supervisor of the Southern Lines West, at Cincinnati, Ohio, has been appointed signal and electrical inspector, with headquarters at Washington, D. C.

W. G. Guess, assistant chief despatcher of the Virginia division of the Seaboard Air Line, with headquarters at Raleigh, N. C., has been appointed chief despatcher, succeeding T. A. Norris, promoted.

E. Hacking, master car builder of the Grand Trunk Pacific, with headquarters at Transcona, Man., has been appointed assistant master builder on the Canadian National, with headquarters at Winnipeg, Man.

John F. Long, district inspector maintenance of equipment of the Baltimore & Ohio, has been appointed division master mechanic of the Connellsville division of the Eastern district, succeeding H. J. Buckley.

A. H. Eager, mechanical superintendent of the Canadian National with headquarters at Winnipeg, Man., has had his jurisdiction extended over the lines of the Grand Trunk Pacific, with the same headquarters.

F. J. Tew, formerly master mechanic of the Manila Electric Railroad & Light Corporation, has been appointed superintendent of shops and equipment of the Sacramento Northern, with headquarters at Chico, Cal.

C. D. Rex, signal supervisor of the Southern Lines West, with headquarters at Oakdale, Tenn., has been appointed signal and electrical supervisor with headquarters at Cincinnati, Ohio, succeeding T. N. Charles.

E. D. Hawkins, equipment engineer of the Great Northern, with headquarters at St. Paul, Minn., has been appointed general superintendent of motive power of the Atlantic Coast Line, with headquarters at Wilmington, N. C.

C. L. Emerson, division master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Perry, Iowa, has been transferred to the Chicago terminal, with headquarters at Chicago, Ill., succeeding F. Hopper, resigned.

E. R. Gorman, assistant superintendent of motive power of the Chicago, St. Paul, Minneapolis & Omaha, at Eau Claire, Wis., has been appointed acting superintendent of motive power and machinery, with headquarters at St. Paul, Minn.

John A. Fenno, treasurer and superintendent of the Boston, Revere Beach & Lynn, has been elected president, succeeding M. O. Adams, deceased; and Karl Adams has been appointed treasurer and superintendent, succeeding Mr. Fenno.

Laird W. Hendricks, superintendent of shops of the New York, New Haven & Hartford, with headquarters at New Haven, Conn., has been appointed mechanical superintendent of the Bangor & Aroostook, with headquarters at Derby, Me., succeeding H. Shoemaker, resigned.

J. A. Houston, trainmaster of the Dakota division of the Chicago, Rock Island

& Pacific, has resigned to accept an appointment in the engineering department of the Westinghouse Electric & Manufacturing Company, where he will have charge of questions pertaining to the mechanical design of electric locomotives.

Julius H. Parmelee, the accomplished statistician of the Bureau of Railway Economics, with offices at Washington, D. C., has been appointed by the President, Director of the Bureau. R. J. Leimer, formerly assistant statistician, has been appointed statistician, and J. E. Monroe has been appointed assistant statistician, with offices at Washington, D. C.

Charles Whiting Raker, C. E., who has been for many years engaged in editing and publishing text-books and other engineering publications, has changed his sphere of engineering activity and has opened exchange offices in New York for the purpose of bringing together those interested in the publication or purchasing of technical works generally and engineering publications particularly. Mr. Raker has already met with much success in his educational work which will, no doubt, be continued in his new field.

Charles Donnelly, executive vice-president of the Northern Pacific, has been elected president to succeed J. M. Hannaford, who has resigned to become vice-chairman. Mr. Hannaford has been connected with the road for forty-eight years, and the newly elected president is forty-eight years of age, and has also served many years in the company's employ with marked distinction. Mr. Hannaford will continue to give the company and its officers the benefit of his experience, knowledge and advice in the management of its affairs.

OBITUARY.

A. A. Maver.

The death is announced of A. A. Maver, for many years master mechanic on the Grand Trunk Railway of Canada. Mr Maver was a native of Brechin, Scotland, and came to Canada at an early age, and served an apprenticeship as a machinist in the Montreal shops of the Grand Trunk, and was successively advanced to many positions in the mechanical department of that railway. He was appointed master mechanic in 1901, and retired on superannuation a few years ago. He died in Jersey City, aged 71.

Richard L. O'Donnel

Richard L. O'Donnel, vice-president of the Central region of the Pennsylvania, with headquarters at Pittsburgh, Pa., and for nearly forty years connected with the Pennsylvania, died on September 28, in New York City, in the sixtieth year of his age. He entered the service in the engineering department, and latterly was transferred to the transportation department. He was promoted to assistant general manager of the lines east of Pittsburgh in 1917, and general manager in 1918, serving under Federal control, and elected vice-president in March of the present year. Mr. O'Donnel had charge of the movement of troops to the Mexican border in 1916, and in 1917 had charge of the embarkment of troops and supplies.

Twentieth Annual Convention of the Chief Interchange Car Inspectors' and Car Foremen's Association

The annual convention of the above Association was held at the Windsor Hotel, Montreal, P. Q., September 14-16 inclusive. President J. J. Gainey, presiding. In the course of his opening address the chairman pointed out the progress that had been made during the year in car construction particularly in the standardization of car construction and maintenance generally, and in interchange matters particularly. Papers were submitted on "Transfers and Adjustments of Lading under the American Railroad Administration for Mechanical Defects," by J. M. Gitzen; "Transportation of Explosives," by J. E. Grant of the Bureau of Explosives; "The Elimination of Loss and Damage to Freight," by E. Arnold, freight claim agent of the Grand Trunk; "Lubrication of Freight and Passenger Equipment," by J. M. O'Connor; "Best Methods of Repairing Cars in Train Yards," by O. E. Sinerly. The Chicago Railway Equipment Company gave an interesting display of moving pictures showing good and bad practices in designing and maintaining brake beams, brake shoes and other equipment. The following were elected officers: President, E. Pendleton, Chicago & Alton; first vice-president, A. Armstrong, Atlanta, Ga.; second vice-president, W. F. Wertall, New York Central; secretary-treasurer, W. R. Elliott, Terminal R. R. Association of St. Louis. W. H. Sherman, Grand Trunk, and A. Herbster, New York Central, were elected members of the Executive Committee.

BOOKS, BULLETINS, ETC.

Data Book for Engineers.

Published by the Locomotive Superheater Co., New York, 79 pages.

This little handbook is a compilation of boiled down data which is most frequently needed by the steam plant operator. It is only at the outset that the user, for it is not a book to be read, has the faintest intimation that it is published in the interest of superheated steam, and this is contained in a chapter of eight pages on the Factors Governing the Advisability of Using Superheated Steam. Here there is a cold blooded statement of the facts and possibilities in the use of superheated steam with which most engineers are or ought to be familiar. There is no hysteria of advocacy of superheating as the cure-all for every known failing, but simple statements to which no exception can be taken, and in everything there is such a wide range of possibilities shown that they must be acknowledged to cover all cases. For example in discussing fuel costs the saving in consumption is placed at from 6 per cent to 20 per cent "depending on conditions" and in engine performance the outside figures for saving, in the case of condensing turbines, is given a range of from 9 to 34 per cent. There is a discussion of the possibility of saving in cost of maintenance and labor on the ground that there will be less wear and tear and that labor, under improved conditions, will be more efficient. Then follows a series of tables covering a wide range of subjects which are well classified and brought together.

The first of these tables are borrowed from the second edition of Hubbard's Steam Power Plants and will be of especial value to those interested in stationary work. It consists of tables showing the sizes of boilers, and their settings for the greater portion of the special types of boilers now upon the market. These cover a wide range of sizes and horsepower, so that by reference to them the prospective user can determine on about what space he must allow for any type of boiler that he may select, and also the steam pressures that he can use. And this is supplemented by chimney tables whereby their dimensions may be ascertained for any size of boiler plant.

The subsequent tables cover a wide variety of subjects that will be of interest not only to the stationary engineer but to engineers at large. These include pipe, tube and screw tables and a very complete and excellently well-arranged metric conversion table. There are the dimensions of tanks of various capacities, and a great deal of information regarding piping.

By permission of the Green Engineering Co. there is a most excellent and complete tabulation of the analyses and heat values of the principal coals of the United States. These analyses cover moistures, ash, volatile matter and fixed carbon and are given for 342 operations in 26 states so that practically the whole territory of the country is covered.

The book closes with a most excellent steam table of the properties of saturated and superheated steam.

Armstrong Tools.

Catalogue B-20, issued by the Armstrong Bros. Tool Company, Chicago, supersedes all of their previous catalogues; 125 pages are devoted to details concerning their popular tool holders for turning, boring, threading, knurling, cutting off, planing, slotting and drilling metals. Varieties of ratchet drills, drop forged wrenches, lathe dogs, machine shop vises and drifts, planer jacks and other machine shop specialties are described in detail and finely illustrated, with price lists annexed. Over 20 pages are devoted to new and improved tools, including sets of automotive wrenches. These are forged from chrome nickel alloy steel, heat treated, tempered and finished, and are as near perfection as can be hoped for. The same may be said of the company's recent development of knurling tools that stand the severest tests. Copies of the new catalogue may be had on application to the company's main office, 315-357 North Francisco avenue, Chicago, Ill.

The Locomotive Booster.

The Franklin Railway Supply Company, New York and Chicago, has issued a finely illustrated bulletin, No. 975, furnishing details in regard to the recently perfected locomotive booster which is attracting wide attention among the leading mechanical men, and bids fair to come into popular use at no distant date. We took occasion in the September issue of RAILWAY & LOCOMOTIVE ENGINEERING to point out the details of its construction and particular serviceability in applying power to the trailing wheels of a locomotive in starting and on grades, but those interested could have full particulars in a more convenient form by applying to the company's main office, 30 Church street, New York, for a copy of the Bulletin.

Rail Bonds.

Bulletin No. 44002 A, superseding bulletin No. 44002, issued by the General Electric Company, treats fully of rail bonds and bonding tools. Numerous forms of bonds are described and illustrated. Forms of bonds include compressed stud, tabular stud, twin stud, and the oxy-acetylene and arc weld process terminals. The best means and methods are clearly set forth in concealed and exposed bonding. Many accessories are also listed including hand and electric drills, bond compressors, a portable bond tester. A most compact conversional table of linear values concludes the comprehensive bulletin. Copies may be had on application to the general office of the company, Schenectady, N. Y.

Lubrication.

The Texas Company's Bulletin for August reminds us that the enterprising company not only furnishes lubricants that have stood the highest tests, but they furnish Texaco lubrication experts who are qualified to co-operate in prescribing the right lubricant for every machine in every kind of plant. Not only so but there is no obligation incurred in asking for an inspection.

G. E. Insulating Compounds.

The General Electric Company has just issued bulletin No. 48704 A, G. E. Insulating Compounds, superseding bulletin No. 48704, presenting the principal characteristics and effective adaptations of insulating and coating materials in a practical manner. This is a work of extensive research and experience, and the data given embraces all that is known up to the present time in regard to impregnating and sealing compounds adapted to insulating electric apparatus and accessories. Full information is also given on the application of the various compounds, and the best methods of treatment.

Welding.

The Chicago Section of the American Welding Society has issued a booklet, the title of which is "Keep the Guesswork Out of Welding." Copies may be had by addressing the American Welding Society, 608 South Dearborn street, Chicago, Ill.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

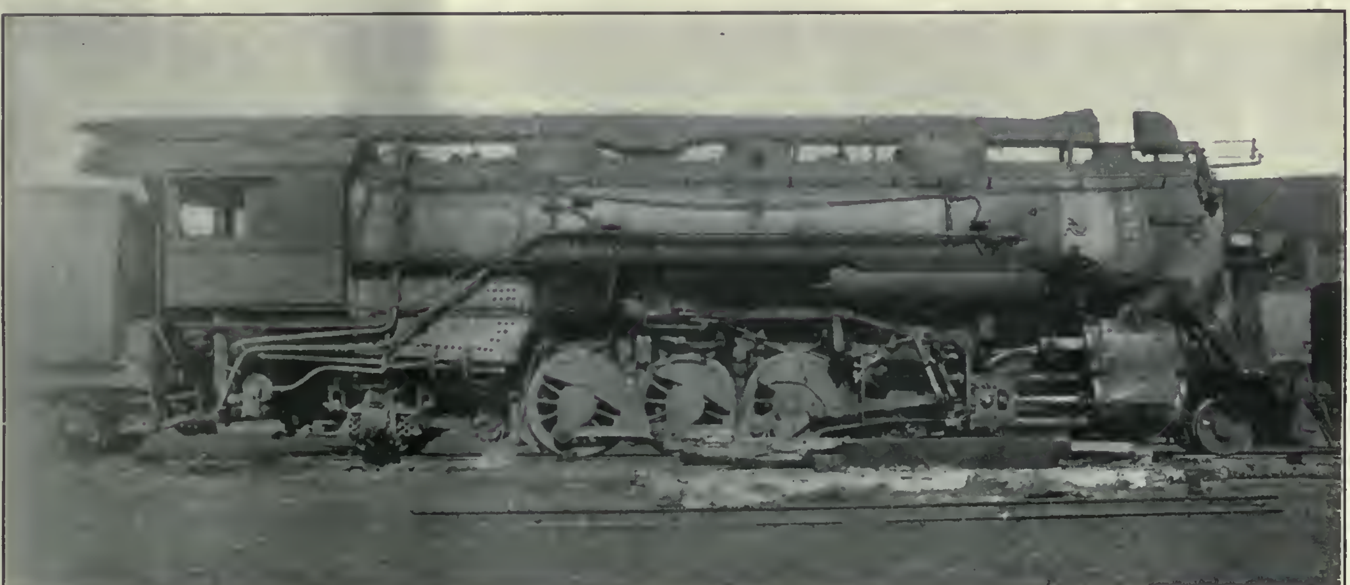
Vol. XXXIII 114 Liberty Street, New York, November, 1920 No. 11

Locomotive Smoke Duct for Tunnel Service

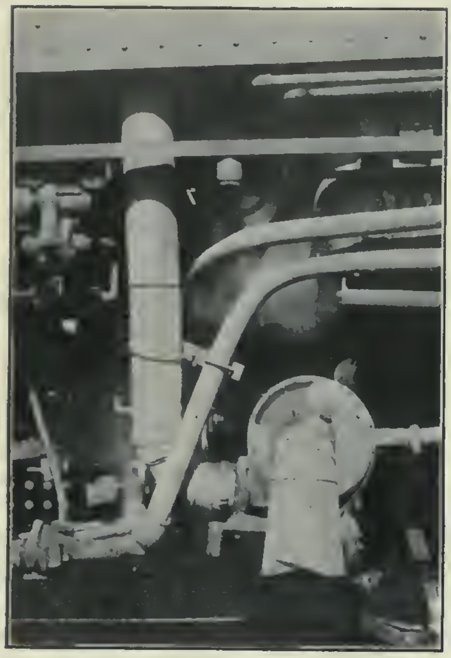
In Successful Operation on the Cincinnati, New Orleans and Texas Division of the Southern Railway

That portion of the Cincinnati, New Orleans and Texas Pacific Division of the Southern Ry., running from Cincinnati to Chattanooga, passes through a number of very hot and disagreeable tunnels. They are not always very long but many of them are exceedingly hot and stifling when heavy engine work is done. Under ordinary working conditions the men usually bury their faces in bunches of waste to protect themselves, but when the heavy Santa Fe engines were bought it was found that they so nearly filled the tunnels between Danville, Ky., and Oakdale, Tenn., that the gases were choked and filled the cab to such an extent that the crews were nearly asphyxiated, and with hot weather conditions they became intolerable. In order to overcome the difficulty a supplementary conduit was placed from the stack along the top of the boiler with an outlet at the back end of the cab bonnet. This was made of 3/16 in. steel, and, under normal open air working conditions, it was cleared above the stack and the engine worked in the ordinary manner. On entering a tunnel the bonnet shown in the photograph just ahead of the stack is drawn back by a piston and rod working in an air cylinder, so that the stack is covered and the exhaust gases are directed back into the conduit. This is effectually accomplished and the gases are led back to the outlet designated. The wear of the bonnet immediately above the stack is, of course, quite severe, considering the comparatively short periods of time during which it is in service. An interesting detail of this wear is that the gases, after following the curve of the hood and being turned back, apparently go down to the bottom of the conduit and then rebound, striking the top again near the center of the engine, where, next to the hood, the greatest amount of wear takes place.

In order to add to the comfort of the men and prevent the possibility of the entrance of the gases at the back of the cab a small rotary blower is installed beneath the foot plate on each side of the engine. These blowers are driven by small steam turbines and, taking air outside the rails and a short distance above the ties, they deliver it into the cab back of and at the sides of the seats of the engineer and fireman, respectively. This furnishes a cool blast of air and creates a draft from the cab out into the air, with a result that the interior is kept quite free from smoke and gas and is as comfortable



VIEW OF LOCOMOTIVE EQUIPPED WITH SUPPLEMENTARY SMOKE CONDUIT ON THE CINCINNATI, NEW ORLEANS AND TEXAS DIVISION OF THE SOUTHERN RAILWAY as the ordinary coach. In fact, so much do these blowers add to the comfort of the cab that they are kept running at all times in hot weather and the tunnel temperature of the cabs are from 10 degrees to 15 degrees F. below that of the same when running in the open. This is in contradistinction to the intense heat prevailing before the application of the conduit and fans,



CAB BLOWER AS USED ON SANTA FE TYPE LOCOMOTIVE

when the temperatures were so high that after a few trips the overalls of the men were ruined and could be picked to pieces.

The method, while not highly ornamental to the engine, is very efficient, and though the maintenance cost of the duct is somewhat high it is probably less expensive than the installation and maintenance of a plant for tunnel ventilation would be.

Kansas City Southern Shows Gross Income Advances.

As indicating the result obtained by the increased rates in railroad transportation the Kansas City Southern, the first railroad to issue its September report showing the effect of the higher freight and passenger rates in the Southwest, revealing substantial increases in gross and net earnings over the results of the corresponding period of a year ago. Gross revenues of the company for September totaled $2,378,100, contrasted with $1,478,884 for the same month a year ago. The territory served by the Kansas City So[illegible] was granted an aggregate increase [illegible] 35 per cent in freight rates. Of th[illegible] total $744,984 was saved for [illegible] come, being an increase of [illegible] 148 [illegible] the September, 1919, opera[illegible] Officials of the road report t[illegible] October indicate that the re[illegible] will [illegible] little change from the Septe[illegible]

Bending Machine in the Shops of the Norfolk & Western Railroad

In the boiler shop of the Norfolk & Western shops at Roanoke, Va., there is a homemade bending press operated by air which is used for bending plates to any desired angle. It consists of a bed plate 6 ft. 2 in. long and about 6 in. wide. Immediately above the bed plate there is a crosshead or clamping head (A) which is moved by a couple of 18 in. pistons coupled together, and operated by air. These serve to hold the clamping head down on the work and to raise it when the bending has been done.

Hinged directly in front of the bed is the bending plate. This is so hinged that its inner edge is pivoted in a line with the front edge of the bed. This is shown by the sketch in which B is the bed and C the bending bed in its lowered position, the dotted lines showing it raised. Projecting out from this bed are two arms, (D) one at each end, A wire rope E is attached to each of these and passes up on an angle, beneath a grooved pulley and is attached to the rod of a piston moving in the cylinder F.

To the arm at one end of the bending bed a rod G is attached which is raised and lowered as the bed moves up and down. The rod carries a trip which engages a latch rod when the desired bending angle has been reached. As the trip strikes the latch rod it moves it to the right and draws the latch away from the valve handle of the upper cylinder.

BENDING MACHINE USED IN NORFOLK AND WESTERN SHOPS

Ordinarily this valve, which is an ordinary three-way cock, stands so that air is cut off from the cylinders and the exhaust is open and it is held in that position by a [illegible]ing.

[illegible]rate the machine the piece to be [illegible] in position and the clamp- [illegible]wn against it. The valve handle of the upper cylinders is pulled down so that it is caught by the latch. This is done by a wire attached to a ball serving as a weight. This admits air to the upper cylinders, and their pistons rise pulling on the wire ropes until the latch is tripped when the spring opens the valve and the piston and bending bed fall back. As the trip moves away from

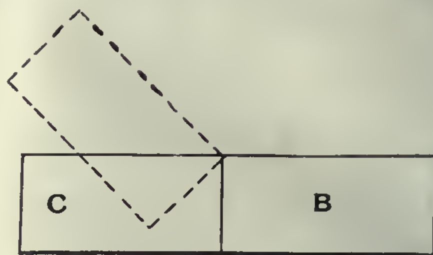


DIAGRAM OF BENDING TABLE AND PLATE

the latch, the rod of the latter is pushed to the left and the latch placed in position to catch the valve handle when it is again drawn down.

The press not only bends plates and bars but can be set to bend the arch bars for the diamond truck without the use of formers. It is merely necessary to lay off the points at which the bending is to be done, and set the machine to bend to the proper angle, put the bar in the machine with the successive points in proper position, and the work is quickly done.

A case in point frequently occurs where an angle bar is needed in the repair yard. Although the machine may be occupied on stock work the arch bar is brought in, the machine reset, and the bar bent while the men wait for the two or three minutes needed to finish the job.

Bronzing Cast Iron

For many purposes it is desirable that cast iron should have the appearance of bronze, while it is not possible to electroplate it, on account of cost. A simple and inexpensive method is to clean the iron and apply an even coat of olive oil, heating the metal afterwards, but not sufficient to burn the oil. When the oil is about to decompose through the heat, the iron absorbs oxygen, which causes the formation of a hard skin of brown oxide on the surface, which holds very firmly and is hard enough to admit of polishing, the finished surface having the appearance of bronze. The surface of the casting naturally determines the smoothness of the finish, a finely ground polished surface giving the most brilliant results, while a rough surface gives the poorest. Some experience in working is necessary as a general rule, for the process depends largely on the care of the operator.

Comprehensive Tests of the Booster Locomotive on the New York Central Railroad

Complete Official Data of Its Effective Performance

In the September issue of Railway and Locomotive Engineering we published a brief description of what is known as a booster applied to a locomotive. The appliance, which is the invention of Howard L. Ingersoll, assistant to the president of the New York Central Railroad, was exhibited at the Atlantic City Mechanical convention and attracted wide attention among the leading railway men. It could be seen at a glance that its application to a modern high-powered locomotive would greatly facilitate the starting of heavy trains as well as add to the capacity of negotiating grades when the breaking of loads or the adding of helper locomotives

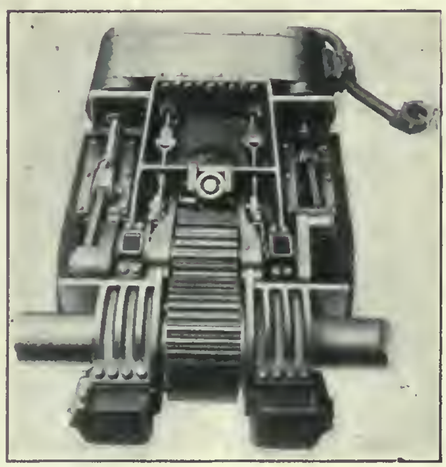
PACIFIC TYPE LOCOMOTIVE EQUIPPED WITH LOCOMOTIVE BOOSTER NEW YORK CENTRAL RAILROAD

VIEWS OF TRAILER TRUCK EQUIPPED WITH THE BOOSTER

is not only conducive to delay but adding considerably to the cost of transportation. It remained, however, to test the merits of the appliance under such conditions as would satisfy the most exacting of railway men, who naturally look for official data in regard to work actually accomplished under conditions that may be regarded as what may be expected in everyday service. To this end records have been kept of the operations of engine 3149 of the New York Central railroad, equipped with the appliance, and reports have been made from time to time bearing out all that has been claimed for the appliance, and while these have been eminently satisfactory, it only remained that some special test should be made at some particular portion of the road where the merits of the device could be fully tested under the severest conditions, and by the use of dynamometer and other appliances under exact supervision, and in the presence of experts well qualified to note the results both from an engineering and economic standpoint to the end that the merits of the appliance might be completely established, the report recently issued presents in detail the particulars in regard to the tests.

"Idle weight and spare steam harnessed in a simple way to do useful work at a critical time." This, in a few words, describes the locomotive booster which causes the trailing wheels to act as driving wheels in starting the train and to get it over the hard pulls on the road. For the past ten years or more locomotive designers have been striving for increased drawbar pull. Their efforts have increased the load per pair of drivers and the number of driving wheels until today the load limit that track and bridge structures will bear has been closely approached. In starting and at slow speeds every locomotive built has greater boiler capacity than it can utilize. While, of course, increased wheel loads and larger units mean greater tractive effort, the limiting factor, the ruling grade, determines the load a locomotive can haul over the division. To obtain maximum practical effectiveness from the locomotive and offset the tonnage limit imposed by the ruling grade several methods are in use. One is to station pushers at the foot of the grades to help the train over the hill; another is to make up the train, wherever possible, so as to drop several cars at some way point. Both are expensive and unsatisfactory.

Loading locomotives to the limit involves several other perplexing operating problems. A water plug located at the foot of a momentum grade necessitates cutting loose and running for water. Stopping for signal or other cause on a hill may necessitate backing down to get started again. Loss of time in starting



TWO-CYLINDER ENGINE GEARED TO THE TRAILER AXLE

disrupts train schedules and often results in loss of train rights with consequent overtime, as well as increased operating costs.

Locomotives as ordinarily built today are hauling around a large percentage of weight that is useless except to permit of making the boiler larger. To permit train loading that would utilize a greater percentage of the available draw-bar pull over the entire division and yet have sufficient power available for the critical points where extra power led to the invention and development of the locomotive booster.

For approximately two years Engine 3149 equipped with the booster has been in operation on the New York Central. To determine the operating advantages of the booster, a series of tests was conducted on the River division between Ravena and Weehawken. This division is 130 miles long with a ruling grade of one per cent at Bogota going west and 0.46 per cent at Haverstraw going east. The locomotive used in these tests, 3149, is of the Pacific type with a load on drivers of 184,000 lb., steam pressure 200 lb. and a tractive effort of 40,000 lb. It was exhibited at the Atlantic City convention and has been in continuous road service since that time; no special preparations were made for the test. A dynamometer car was used to obtain the necessary data.

In making these tests information was wanted on the following items:

1. Practical increase in tonnage that could be hauled over the division because of the booster.

2. Effect of the booster on train operation over the division.

3. Maximum drawbar pull with the booster in action.

4. Maximum drawbar pull without the booster.

5. Time saved over the division because of the booster.

6. Increased train acceleration by use of the booster.

7. Effect of a crew, inexperienced with the booster, operating a locomotive equipped with a booster.

Test Results Going East

The first test was made going east from Ravena to Weehawken. Without the booster, Engine 3149 is rated from Ravena with 2,600 tons and runs to Newburgh where the tonnage is reduced to 2,100 tons, a reduction of 19.2 per cent. In making this test it was decided to endeavor to bring 2,582 tons through to Weehawken. This not only involved getting over the ruling grade at Haverstraw, but also introduced other interesting and important operating problems.

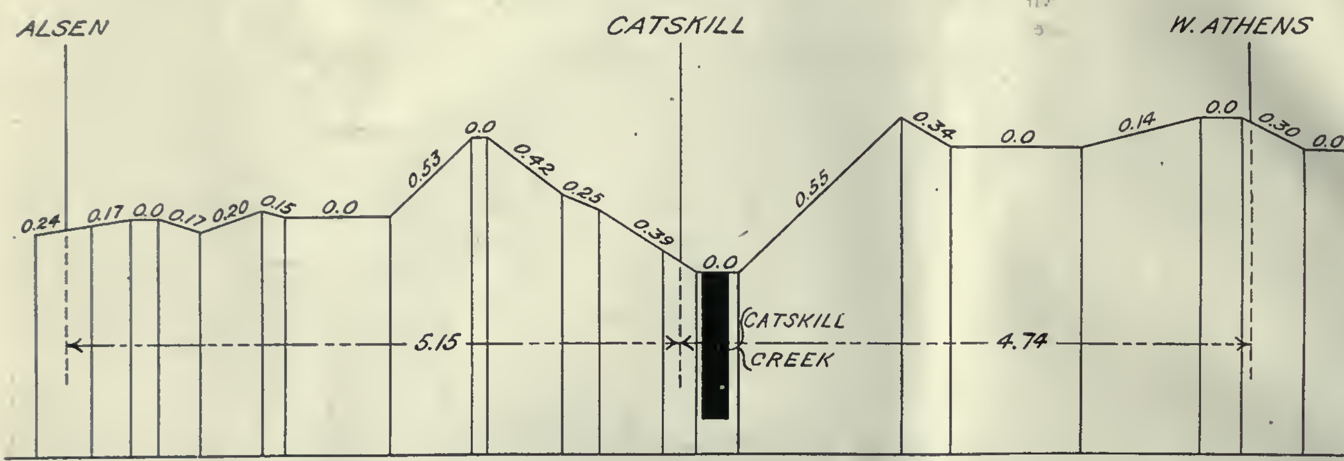


FIG. 1.

DIAGRAM OF PROFILE OF WEST SHORE DIVISION AT CATSKILL

At Catskill the water plug is located at the bottom of two grades. It is the usual practice to leave the train at the top of the grade west of the water plug, run two miles for water, back up to the train and make a run down-grade to get sufficient momentum to carry over the up-grade. The profile of the road at this point (Fig. 1) shows a down-grade of 0.55 per cent and an up-grade averaging 0.375 per cent. Running for water in this way consumes 20 to 30 minutes' time in good weather. When the weather is bad with sleet and snow 30 minutes' time is usually lost in pumping up the train line alone before the train can be started after

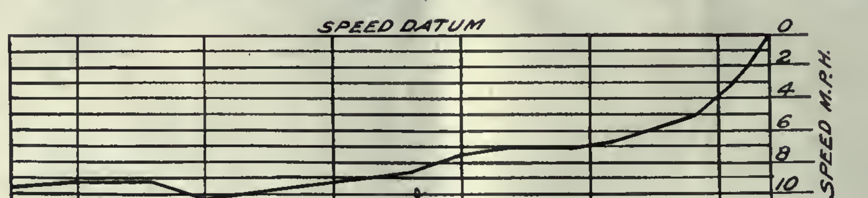


FIG. 2.

DYNAMOMETER RECORD OF BOOSTER LOCOMOTIVE ON THE CATSKILL GRADE coupling up, thus more than doubling the time lost.

In the test run the practice referred to was not followed. Engine 3149 hauled the train to the water plug intact, took water and started up the grade with the full train with the booster in operation. As shown by the dynamometer record (Fig. 2) the locomotive, with the booster in operation, accelerated to five miles per

RULING TONNAGE FOR WEST SHORE DIVISION

Distance	Weehawken 0 miles	Cornwall 52 miles	Newburgh 57 miles	Kingston 88 miles	Ravena 129 miles
Tonnage Going East Without Booster	......	......	2,100 tons	......	2,600 tons
Tonnage Going East With Booster	2,582 tons	......	......	......	2,582 tons
Tonnage Going West Without Booster	1,800 tons	......	2,100 tons	2,600 tons	......
Tonnage Going West With Booster	2,015 tons	2,577 tons	......	2,745 tons	......

another 30 minutes' delay in addition to the time lost at Catskill. After leaving Catskill the booster was used for starting whenever the train was stopped for signals or other reasons, each start showing rapid acceleration.

The ruling grade on this division is known as the Haverstraw grade (Fig. 3). It is over six miles long and the average gradient is about 0.46 per cent. This grade was approached at a speed of 33 m. p. h. with the booster idle and continuing upgrade the speed dropped as follows:

At the end of the first mile, 28½ m. p. h.
At the end of the second mile, 19 m. p. h.
At the end of the third mile, 12 m. p. h.
At the end of the fourth mile, 8 m. p. h.
At the fifth mile the speed was 7½ m. p. h. and falling rapidly. The drawbar pull was 36,441 lb. Without the assistance of the booster the train would have stalled.

At this point the booster was cut in on a 0.52 per cent grade, and in 432 ft. the speed reached eight miles per hour and

crease of 24.6 per cent over the regular tonnage.

Test Results Going West

By referring to the tabulated statement it will be noted that the tonnage rating of this locomotive without the booster is 1,800 tons to Newburgh, at which point it is increased to 2,100 tons to Kingston, where it is again increased to 2,600 tons to Ravena. Use of the booster permitted increasing the tonnage to 2,015 out of Weehawken, increasing it to 2,577 at Cornwall and again increasing it to 2,745 tons at Kingston, which tonnage was hauled to Ravena.

The ruling grade going west on this division begins 7 1/3 miles from Weehawken at Bogota. It is one per cent grade approximately 1¾ miles long. The dynamometer record was started at a point eight miles from Hoboken, where the speed was 25 miles per hour, and about two-thirds of the way up, the speed had dropped to 13 miles per hour. At this point the booster was cut in. The drawbar pull immediately

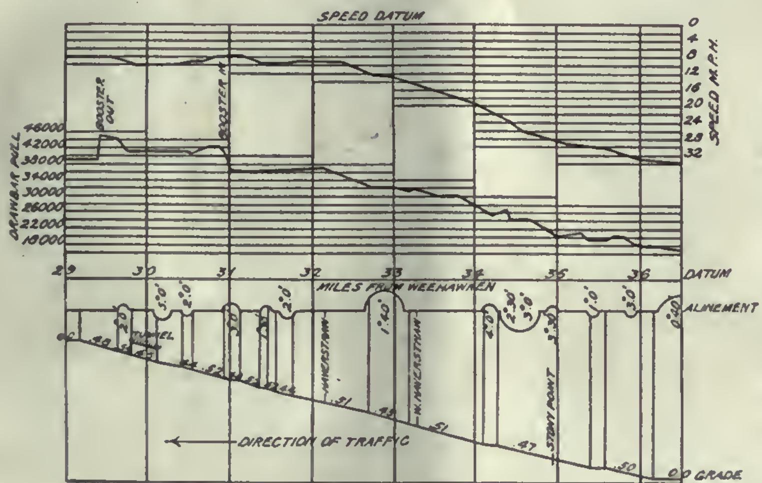


FIG. 3.

PERFORMANCE OF BOOSTER LOCOMOTIVE WITH 22.6 PER CENT EXCESS TONNAGE ON HAVERSTRAW GRADE

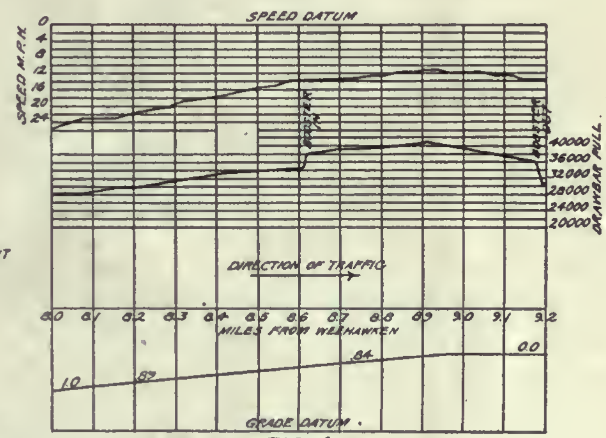


FIG. 4.

DRAWBAR PULL AND SPEED RECORD ASCENDING BOGOTA GRADE

hour very quickly, the drawbar pull showing 41,067 lb. at this point and in a distance of 580 ft. the speed increased from 5 to 8½ m. p. h., or an increase of 70 per cent. When the booster was disengaged and the locomotive took the load entirely, the drawbar pull showed 33,497 lb., a difference of 7,570 lb.

Reference to Fig. 1 showing the road profile and Fig. 2 showing the dynamometer record clearly indicate the part the booster played in making possible the starting of the train and getting up to speed on the grade; without the booster this performance would have been impossible.

At this point an important time saving operating situation developed. Because of the time saved at Catskill, West Point was reached just three minutes before an express was due. The express was followed to Weehawken, whereas usually two or three local passenger trains are allowed to go ahead. At times this adds

the drawbar pull 42,900 lb., an increase of 6,459 lb. drawbar pull or 17.7 per cent because of the booster. In the first ¾ mile, after the booster was working, the speed reached 10 m. p. h. This shows an acceleration, because of the booster, in three-quarters of a mile of 33 1/3 per cent with a train tonnage 22.9 per cent above normal. In taking this train over the ruling grade the booster was used for about 1⅝ miles and just before being disengaged a drawbar pull of 45,080 lb. was recorded on the dynamometer car.

The train arrived at Weehawken with the same tonnage with which it started from Ravena. This was the first time this tonnage had ever been hauled over the entire division by this type of locomotive. In addition no difficulty was experienced and the locomotive was handled by a crew not regularly assigned to the locomotive. Since this test was made the crew regularly operating this locomotive has hauled 2,618 tons over the division, an in-

increased from 34,228 pounds to 38,793 pounds, an increase of 4,565 pounds.

At West Nyack a test was made to determine the combined power of the locomotive with the booster. The grade at this point is 1.04 per cent. The train was brought to a standstill and a start made by taking slack. As shown by the dynamometer car record, Fig. 5, the train proceeded twenty-two hundredths of a mile when it stalled, and the maximum drawbar pull at zero speed registered 51,138 pounds. The boiler pressure remained constant, the throttle was wide open, and the reverse lever in the corner.

To determine the maximum drawbar pull of the locomotive without the booster, a test was made on an .86 per cent grade into Congers. The tonnage at this point being 1,958 tons, one car having been set off on account of hot boxes. With the booster working the train was brought entirely on the grade, the booster then cut out, and the engine proceeding until stalled. As shown by the dynamometer car record (Fig. 6) the drawbar pull registered 40,421 lb. at zero speed. To get the train moving again the booster was engaged and the maximum drawbar pull registered 49,953 lb., showing an increase of 9,532 lb., or the additional drawbar pull which the booster exerted.

At Cornwall the tonnage was increased to 2,577 tons, the usual tonnage from this point to Newburgh being 1,800 tons. At West Park, on a .52 per cent grade, it was found necessary to use the booster again as the speed had dropped to 12 m.p.h. Upon arrival at Kingston the train was increased to 2,745 tons, which is 145 tons in excess of the regular rating of 2,600 tons, and the train continued to Ravena successfully handling this tonnage.

One of the important features of the booster emphasized by these tests was the rapid acceleration, which is accomplished at practically no increase in weight as the booster weighs less than 4,000 lb. The following tabulation shows clearly the reason for this.

Maximum drawbar pull of locomotive.	40,421 lbs.
Drawbar pull of locomotive necessary to move train on given grade.....	36,441 lbs.
Difference (force available for acceleration)	3,980 lbs.
Maximum drawbar pull of locomotive with booster in operation..........	49,618 lbs.
Less drawbar pull necessary to move train	36,441 lbs.
Reserve for acceleration with booster is increased to..................	13,177 lbs.
Deducting force available for acceleration without the booster..........	3,980 lbs.
Increased force available for acceleration on the same locomotive with the booster operating.............	9,197 lbs.

Hence 9,197/3,980 equals 231 per cent increase in force available for acceleration purposes.

On freight trains this is important, as it enables a quick get-away and the increase in available starting power means a smooth even start. This often saves sufficient time to permit a freight train to continue on its run when otherwise it might necessarily have to take a siding to permit other trains to pass. In addition, it avoids damage to rolling stock by avoiding the need of taking slack.

On passenger trains it means saving time in starting from station or other stops. A few minutes saved at each stop with a heavy train helps maintain operating schedules. The smooth easy start also adds to the comfort of the traveling public.

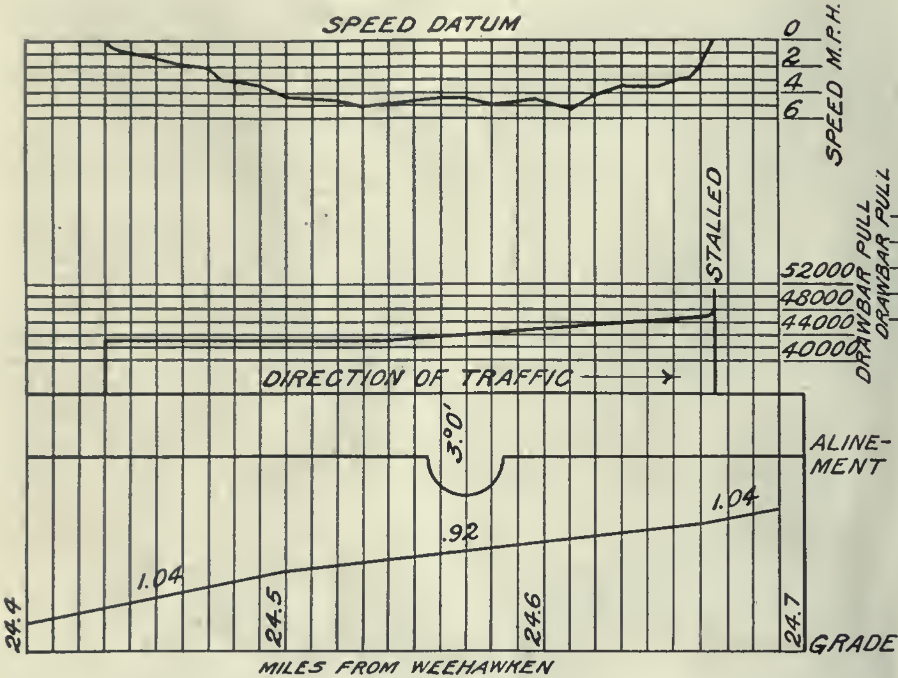


FIG. 5.

DYNAMOMETER RECORD SHOWING STALLING TEST OF LOCOMOTIVE AND BOOSTER, NEW YORK CENTRAL LOCOMOTIVE, NO. 3149

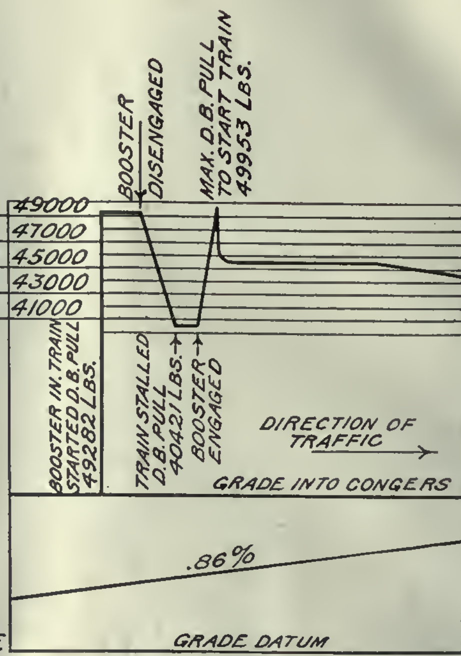
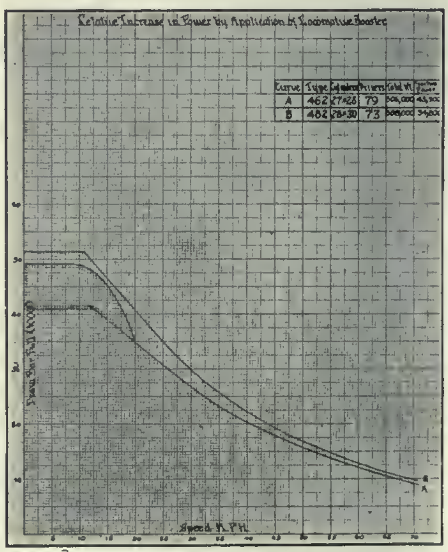


FIG. 6.

STALLING TEST TO DETERMINE MAXIMUM DRAWBAR PULL WITHOUT THE BOOSTER



CURVES SHOWING THE EFFECT OF THE BOOSTER ON LOCOMOTIVES

Conclusions

From the results of these tests the following conclusions were drawn:

1. The booster makes possible increasing the tonnage that a locomotive can haul.
2. It provides quick acceleration that helps maintain schedules more easily and reduces the time over the division. In several instances under observation the time consumed in getting freight trains out of terminals and yards was reduced 50 per cent.
3. It eliminates the need for taking slack in starting.
4. It reduces tire and rail wear as slipping of drivers is avoided.
5. Because of its smooth, steady pull at starting it reduces wear and tear on equipment and eliminates breaks-in-two.
6. It increases the average speed over grades and eliminates stalling.
7. The booster power is always instantly available at speeds below 12 m.p.h.
8. It helps relieve traffic congestion, increasing the maximum ton-miles over the division.
9. No extra coal is consumed because of the booster, and fuel economy should result because the time required over the division is reduced.
10. The booster is automatic in operation and control and adds no extra duties to the engine crew.

11. It gives the effective increase in starting drawbar pull that an additional pair of drivers would give, but avoids hauling around 50,000 lb. or more weight that a larger locomotive would involve, weight that is useless a large percentage of the time and that present track and bridge structure will not carry.
12. The booster is in motion less than 10 per cent of the time. Its maintenance is negligible.
13. It avoids stalling where sudden weather changes while enroute would render impossible the hauling of normal tonnage.
14. It provides a reserve capacity that helps to even out the difference between an experienced and inexperienced crew.

Diesel Electric Locomotives on Railways.

It is reported that a new type of motor coach has been introduced on secondary lines in Sweden where traffic is insufficient for the usual steam-driven. Cars known as size No. 1, 4 ft. 8½ in. gauge, have an overall length of 52 ft. 6 in., a net length of car of 49 ft. 6 in., and an overall width of 10 ft. 4 in. The length of wheel base is 32 ft. 10 in., and the distance between each pair of axles 5 ft. 11 in. The car weighs 29.3 tons and motive power is supplied by a 75 h.p. four-cycle Diesel oil engine having six cylinders and running at a speed of 550 revolutions per minute. Fuel oil is fed by a common oil pump to the oil inlet valves through which it is injected into the cylinders by air at a pressure of 60 atmospheres supplied by an auxiliary air-compressor, or, when starting, from an automatic air receiver. The exhaust gases pass through a silencer and are discharged over the roof of the car. All the cylinders are water-jacketed and the warm water circulated to heat the car during winter. A 550-volt C.C. shunt-wound dynamo, specially designed in order to economize floor space, drives through a flexible coupling on the flywheel. The oil engine starting gear is connected to the accumulators. The motors are fully enclosed and fitted with hand holes to facilitate inspection of the transmission gear, also enclosed in weatherproof casing. The speed on the level is 33 miles, and with a rise of 1 in 200, 24¼ miles per hour. A rise of 1 in 100 and 1 in 60 reduces the speed to 17⅜ and 11¾ miles per hour, respectively.

The machinery can be operated from either end of the car, both platforms being provided with all the necessary gear. The starting lever for the oil engines is fitted with "dead man's grip." The motor, which is stopped when descending an incline and in stations, starts automatically by current from the accumulators when required. Experience has proved that the oil engine only works 60 to 70 per cent of the whole distance traveled; a considerable saving in power is thus effected and all noise and vibration when the car stops is avoided. The quantity of Texas oil used by the No. 1 size car when operating under peak load conditions was .422 lb. per h.p.-hour. The 75-h.p. motor then developed 120 b.h.p.

The motor coach is built in four different sizes. Sizes 1 and 3 are for the standard gauge of 4 ft. 8½ in., and sizes 2 and 4 are for narrow gauge lines (2 ft. 11⅝ in.). Sizes 3 and 4 have 120-h.p. oil engines and weigh 32.85 and 27.6 tons, respectively, while size 2 complete only weighs 26.4 tons.

The True Meaning of the Transportation Act

W. W. Atterbury, vice-president in charge of operation of the Pennsylvania System, in an address before the Chamber of Commerce, Harrisburg, Pa., stated that "Some men were under the belief that the rate provisions of the Transportation Act guarantee each company 5½ per cent on its capital stock. Others think it means 5½ per cent on all securities lumped together. Still others believe each company is separately guaranteed 5½ per cent on the value of the property. No one of them is correct. The Transportation Act created no guarantee whatever, save the temporary one which expired September 1. Nor do the provisions of the act regarding the making of rates have any relation whatever to the amount of stock or other securities issued. What the act does provide is that the Interstate Commerce Commission shall divide the country up into rate-making districts, according to natural traffic divisions, and then establish such rates in each of the districts so created, as will give the railroads, as a whole, of any given district, an aggregate net return equal to not less than 5½ per cent on the combined value of their property devoted to the public service. In its discretion the Commission may increase the combined yield to 6 per cent, and, as a matter of fact, did so in its recent rate award.

"The Commission divided the country into four districts, consisting, roughly, of (1) the region west of the Rockies; (2) the central portion of the country east of the Rockies and along the Mississippi; (3) the Southern States; and (4) the Eastern States, including New England.

"The Commission, using its own methods, which differ somewhat from those of the railroad accountants, fixed upon a valuation for the total railroad property in each of these four districts, and then readjusted the rates to levels which, in the Commission's belief, will, under efficient management and a continuance of the present volume of traffic, give an aggregate return of 6 per cent on the total value for each district.

"At the rates thus fixed, the railroads are left to compete with each other for the traffic their district affords, and to sink or swim as best they may."

Marked Improvement on the Pennsylvania

The report of improvements in maintenance and operating on the Pennsylvania system since the return of the railroads to their owners is the best proof that real progress is being made, and while all of the roads have not the same commanding position as the Pennsylvania all of the reports are of the most encouraging kind. In regard to motive power and equipment on the Pennsylvania it appears that the number of locomotives undergoing or awaiting repairs at the various shops has been reduced from a daily average of about 1,600, at the termination of Federal control, on March 1st, to 1,000 at the opening of September, and the proportion of locomotives available for service has been increased from 78 per cent of the total in March to 86 per cent last month. From March to August of the present year, 19,750 engines received repairs as compared with 14,371 in the corresponding period of 1919. "Bad order" freight cars have been materially cut down in six months by nearly two-thirds, or from 26,000, when the roads were returned on March 1, to 8,700 at the opening of September. The latter figure was just 3 per cent of the total cars then on the line, or 1 per cent under the mark set by the Association of Railway Executives, in its recent improvement program as the point to which "bad order" cars should be reduced.

These items serve to show progress which extends through all the details of operation. Passenger trains are running much nearer to schedule time. Cars are being loaded more rapidly. There is evidence of a general toning up of the whole system. For in place of a vague, undefined responsibility have been substituted the strict and businesslike methods of the individual interest which has no national treasury to fall back upon. It must deliver the goods in order to prosper. And its prosperity contributes in turn to that of the nation.

Regarding the improvement in passenger traffic for every 10,000 passenger car miles, the total delays to trains due to car trouble, such as hot box, amounted to 3.9 minutes. This is the August figure, the latest available in every 10,000 miles operated by passenger locomotives on the Pennsylvania Railroad, there was an average of not quite three delays to passenger trains because of locomotive trouble. The total number of minutes lost by all of the 129,745 passenger trains on the whole railroad because of locomotive and car trouble, in September, was 53,183, as compared with 60,792 in April.

Marked Improvements in Coal Storage Practice

New Devices Installed on the Leading Railroads

It will be recalled that during the period in which the United States Railroad Administration managed the leading transportation systems, the supervisors of the Fuel Conservation Section issued bulletins on the storage of coal making valuable contributions particularly on the growing need of looking more thoroughly towards the avoidance of the frequent occurrence of the spontaneous combustion of coal. From necessity no general rule can be made which will fit the various coals stored in the different sections of the country, and railroad officials particularly in charge of the work will always be compelled to exercise a reasonable measure of discretion in carrying out any recommendations of a general character that may be made.

It is well to bear in mind the principal suggestions made, and a brief recapitulation of these should be of interest at any time, particularly at a time when strikes seem to be the order of the day and the terror of the night, for whether it be in the flats of Harlem or the flats of Kansas the conservation of fuel remains the burning question of the hour. The railroad men were advised to determine the amount of coal which should be stored during the summer and autumn months, the rate of storage daily and weekly should be prescribed in order to prevent an under or over supply at the storage station. Storage points remote from the supply should be given preference.

As far as possible care should be taken to avoid purchasing coal for storage that bears the reputation of firing when stored. In regard to stove screen lump coal when such is obtainable, 4-inch or 6-inch lump preferably, the portion passing through the 4-inch or 6-inch screen openings to be used for current consumption during the storage period. Coal placed in individual storage piles should come from as few mines as possible. In no case mix coal from different districts or from different seams located within the same district. Before undertaking storage select a suitable location as near as possible to the point of consumption, avoiding hillsides, rough ground, and soft, wet, boggy ground in particular. The storage location should be thoroughly cleaned of all refuse matter, giving particular attention to the removal of vegetation, wood, discarded waste, old clothes, or other similar combustible matter which would assist in starting stock-pile fires or would depreciate the value of the coal when loaded out. Do not pile above a steam pipe over a sewer trap, or against a hot wall. Positive provision should be made for draining the ground so that water may not accumulate at any time under the pile.

It is now well established that coal fires spontaneously by the oxidation of the fine particles, which present the maximum surface for the air to act upon, well-screened coal carefully piled seldom firing, for the reason that a minimum surface is subjected to oxidation, the openings between the lumps admitting of any heat engendered passing off. Fires usually start in piles where the coal is more or less separated in coarse and fine strata, the air entering through the coarser strata acting on the finer portion, which is too dense to admit of the heat created passing off with sufficient rapidity to prevent firing. Fine coal should be invariably stored by itself and in such a way as to exclude as far as possible the air from entering the pile.

Where locomotive cranes are not available, coal from necessity is frequently stored by unloading self-clearing cars placed on a track on the top of the pile, the track raised from time to time on the coal. This arrangement has the disadvantage of causing an accumulation of crushed coal in the center of the pile, with lumps on the outside. Where it is necessary to employ this method of unloading and after the pile is completed, the track should be moved from the top of the pile to the surface level and parallel to the storage pile, thus making provision for the quick removal of any portion that may fire by using the standard railroad non-revolving steam shovel, the American type railroad ditcher, or locomotive crane, for reloading the coal either in case of emergency heating or for current use. Coal so stored should not be piled to a height exceeding 12 to 15 feet, and the reloading tracks should be maintained readily accessible for prompt use in event of spontaneous firing, and the shovel, crane, or ditcher kept readily accessible and always in condition to be used. Where mechanical means are employed for spreading coal so unloaded, a standard railroad ballast spreader is preferable to the track tie dragged through the coal underneath a car truck as commonly done.

Trestle storage should be restricted to the handling of coal of established reputation for safe-keeping. The fire hazard attendant on placing storage coal around the wooden trestle, plus the cost of construction of same, and the difficulty of handling, makes this method of storage inadvisable. Any attempt toward the storage of coal will prove, at best, only partially successful unless some one responsible individual is placed in charge of same with full authority to co-ordinate the various branches of the purchasing and operating departments. A thoroughly competent foreman should be maintained at every storage pile to oversee the storage, to inspect the billing before cars are unloaded, to determine the source of supply and the grade of coal furnished, and to divert to current consumption cars received of grade or kind other than that prescribed.

After the work of storage is completed the storage piles should be adequately policed to prevent wholesale loss by theft and to insure the detection of excessive temperature. It is generally agreed that any method of ventilating stock piles heretofore employed is insufficient to safeguard them. Excessive heating is easily detected by a careful examination of the pile, using the sense of smell; and in addition the inspector should be equipped with a few sharpened steel rods, which should be driven into the pile at frequent intervals. Any excess heat generated may be detected by feeling the rod immediately upon its removal. If a hot spot is found with the rods, the temperature should be carefully watched with a thermometer placed inside a pipe driven into the pile at the hot place.

All coal stored should be picked up and consumed under an established schedule and during the period of car and coal shortage, when transportation is most expensive and the facilities of the carrier are in maximum demand.

Turning our attention to the progress made by some of the railroads it is gratifying to note that considerable ingenuity has been manifested in devising ways and means of fire prevention in coal storage piles. As an instance an innovation in storage trestles has been made by the Seaboard Air Line Railroad in connection with its trestle storage at Jackson

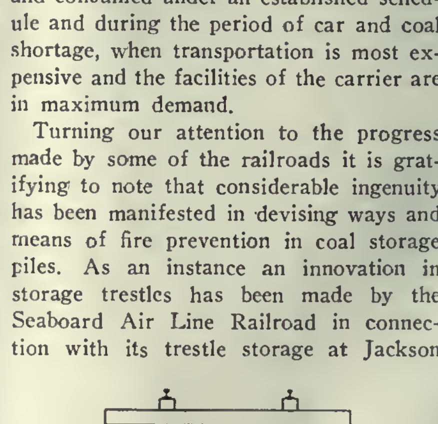


FIG. 1. SECTION VIEW OF COOLING DUCT IN USE SEABOARD AIR LINE

and Savannah, Georgia. Trestles are constructed as shown in Fig. 1, and the ground is covered with plank. The A section extends the entire length of the pile and is made air-tight, except at the ends. The purpose of this flue is two-fold, to help in shifting the coal from under the trestle and thus faciliate loading by crane, and also to act as a cooling agent by conveying cool air the entire length of the trestle without having it come in direct contact with the coal. Run-of-mine coal containing a large amount of slack was stored. An effort was made to store low sulphur coals, because the action of water on sulphur in coal forms sulphuric acid, which breaks up the lumps into slack. At no time was a temperature above 70 degrees noted in pipes placed in the piles.

Fig. 2 shows the standard storage system adopted by the New York, New Haven & Hartford Railroad at three coal storage yards recently installed. A trestle 1,600 to 1,700 feet long and 16 to 17 feet high runs through the center of each yard and on either side is a pair of parallel tracks. The trestle supports are wooden piling and the tracks on top of the trestle rest on steel girders. The two pairs of parallel tracks approach at the yard entrance. On one of the parallel tracks on either side of the center trestle a locomotive crane operates with a swinging boom which transfers the coal dumped from hopper bottom cars running on top of the trestle to piles built up about the trestle and also outside of the parallel tracks. The average height of the coal pile is 20 feet. The coal is trenched to a depth of 8 to 10 feet regularly throughout the pile and in addition ventilation pipes are put down to the bottom of the pile 40 to 50 feet apart. Temperature tubes are inserted in these pipes and readings are taken regularly for indications of heating.

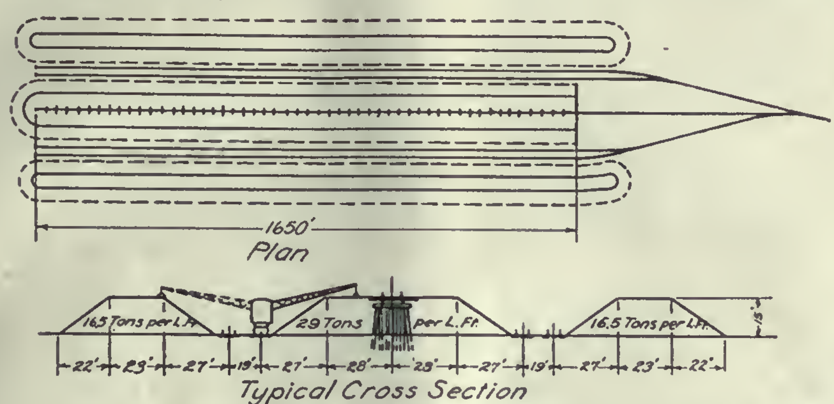


FIG. 2.—PLAN AND SECTION ILLUSTRATING STANDARD COAL STORAGE SYSTEM OF THE NEW YORK, NEW HAVEN, AND HARTFORD RAILROAD (TONNAGE GIVEN PER LINEAR FOOT)

In regard to the liability to heating results have clearly shown that the fire hazard for piles of clean, sized coal is relatively small, compared with that for piles of screenings in mine-run, and that the size is an important factor in connection with storage. It has been reported that 56 per cent of all the piles of mine-runs fired, and that 85 per cent of the piles of screenings fired. Another report shows that 88 per cent of the fires occurred in mine-run or screenings, while of the 132 storage piles of sized coal less than 7 per cent fired.

These results clearly show that screenings or mine-run coal should not be stored in large quantities excepting under water, but if it is necessary to store these sizes in any other way, they should be very carefully watched for evidences of heating and means provided for rapidly and promptly moving the coal if heating is detected. A mixture of sizes gives a pile much less void space and hence the heated air is less readily carried off.

When the coal is at a low temperature the oxygen absorption is very little; therefore, there is not much heat generated. This is generally the case with the larger coals or coals free from small dust when there is a usually a path here and there sufficient to allow the heat to get through to the surface by natural means. On the other hand, heaps may be composed of small coal, which may be so dense that there will not be sufficient apertures or paths for the generated heat to escape; the consequence is that this heat gathers, thereby increasing the temperature of the coal, and incidentally, due to the increase of heat, it increases the rapidity and capacity for further oxygen absorption in a given time, thus giving off more heat in a given time than when the heap was cooler. It is also shown that the more the pile is vented the higher the heap can be piled. Generally speaking, 12 to 14 feet is about as high as one should deposit small sized coals; 9 to 12 feet for unwashed mixed coals; for slack a great deal depends upon the composition. Two heaps of slack were allowed to rise 120 degrees before moving. These heaps gave considerable trouble at a height of 10 feet, but even when the height was reduced to 6 feet, there was a tendency to increase in temperature. The opinion of the cause of the trouble was bad washing of the material; thus after a shower, the shale-like material formed a plastic mass with the coal practically preventing any escape of heat.

A study of the effect of the methods of piling indicates that the lowest percentage of fire occurs where the coal is stored by hand. It is, however, only the small low piles which are piled by hand, and as pointed out previously, the depth of the pile and to some extent the quantity of the coal piled are factors in the liability to spontaneous combustion. Any mechanical method of piling should be so devised that there will be the least possible segregation of the sizes of coal and the least possible breakage in handling. The coal should be distributed in layers over the whole or a considerable part of the pile and not dropped at one point so as to produce a conical pile. In a conical pile the fine material is generally found at the center and the lumps at the outside and toward the bottom of the slope; this arrangement gives a passageway for air to enter the pile and to reach the fine coal near the center, which is the most liable to spontaneous combustion. A number of fires have started at a point within the pile where the flow of the air current was obstructed by the fine coal, thus establishing a condition in which the material most liable to spontaneous combustion was in contact with an excessive amount of oxygen. On account of the rapid oxidation of fine coal, the air current passing through such coal should be greater than that passing through larger sizes, while if the coal segregates in piling just the opposite condition is set up. To prevent breakage the clam-shell or other bucket should be lowered near to the surface of the pile before being dumped.

The common methods of detecting the heating of a coal pile are: by watching for evidences of steaming in the pile; by noting the odor given off; bituminous or sulphuric odors are evidences of heating; by noting places where snow on a pile has melted; by inserting an iron rod in the pile, and by noting the temperature with the hand after withdrawal; by inserting thermometers into the pile and reading directly; by using a pyrometer or plates connected with an automatic recording device.

Temperature readings with a thermometer or pyrometer furnish by far the best and most reliable method for keeping informed on the exact condition of a coal pile. To get the temperature of the inside of a coal pile it is necessary first to provide an opening into which a thermometer or a pyrometer may be inserted. Such openings may be made after the coal is in storage by driving pipes into the pile, but it is easier to place these pipes when the coal is being stored. Pipes left permanently in a pile are a disadvantage as they interfere with the appliances used to remove the coal. Instead of leaving the pipe in the coal pile it is sometimes only necessary to drive it and then withdraw it, the hole remaining open sufficiently to permit the insertion of the thermometer. To prevent the hole from filling with coal, an inverted funnel of paper is used in Canada.

Pipes may readily be inserted in a coal pile, and they should be plugged at the upper end so as to exclude the outside air, for if ventilation is allowed through these pipes, a correct temperature reading of the interior of the coal pile is not obtained.

To prevent the pipe from filling up with coal as it is driven into the pile, a pointed plug may be placed in the end of the pipe and when the pipe has been forced into the pile to the desired depth the plug may be driven out by means of a rod inside the pipe. Before inserting the thermometer the pipe should be pulled up a slight distance so that the thermometer reading may give the temperature of the coal and not that of the pipe.

In regard to thermometers their simplest form for obtaining the temperature inside such temperature holes is an armored maximum registering thermometer, as shown in Fig. 3. A recording thermometer for obtaining the temperature of a coal pile is easily procured. It consists of a recording pen that is operated by the vapor tension from a volatile liquid placed in a bulb at the end of a long, flexible armored tube. This capillary tube is usually about 5 feet in length, but practically any desired length may be used. To register accurately the temperature of the hub must be about that of the atmosphere. The instrument can be equipped with an electrical alarm so that a bell or other means of signal will be operated if the temperature rises to a predetermined danger point.

Fig. 4 illustrates plan and section of coal pile showing arrangement of receptacles

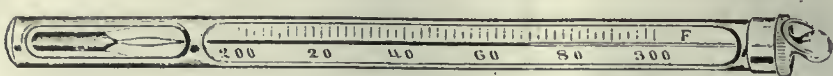


FIG. 3. ARMORED MAXIMUM REGISTERING THERMOMETER

for pyrometers. In regard to what may be called the danger point, the general opinion among experts seems to be that when 100 deg. Fah. is reached a trench

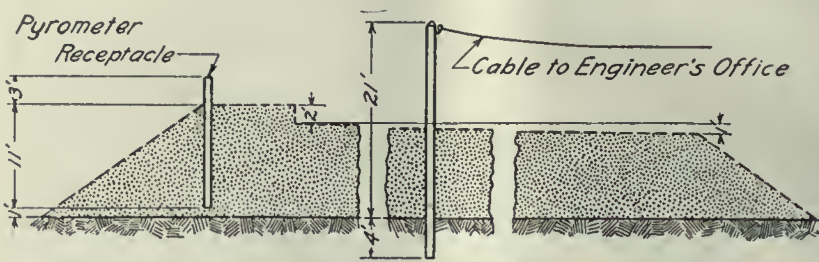


FIG. 4. PLAN AND SECTION OF COAL PILE SHOWING ARRANGEMENT OF RECEPTACLES FOR PYROMETERS

should be dug, or vent pipes inserted. Successful experiments have been made on several railroads with 2-inch flues sharpened at the ends and forced down to the bottom of the pile and worked around, then withdrawn, leaving a hole 3 to 4 inches in diameter, the holes being spaced 5 feet apart. If there is any tendency to heat the number of holes may be increased. The ventilation thus induced has the effect of lowering the temperature in the danger area in nearly every case.

It may be added that the cost of transporting railroad coal during the summer season is estimated as not exceeding 60 to 65 per cent of the cost of such movement during the period of extreme winter weather.

Railroad Engineering Experts Discuss the Relative Advantages of Modern Steam and Electric Locomotives

At a joint meeting of the Railroad, Metropolitan and New York Sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers held at the Engineering Societies Building, 29 West 39th St., New York, on October 22, the relative advantages of steam and electric locomotives were presented with a degree of fulness that added much to the mass of conflicting information on the subject. Under such auspices the contributions to the stock of knowledge in able and experienced hands becomes clarified, and just conclusions may be arrived at when in the course of time the full reports of the papers and the able discussion called forth may be carefully studied by all interested in a subject of such momentous and growing importance. Meanwhile we present abstracts of the three leading addresses delivered and reserve the discussion for some future occasion.

Abstract of Mr. Muhfeld's Address

John E. Muhfeld, Railway and Industrial Engineers Company, in the course of a comprehensive address bristling with illuminating data, claimed that in making comparisons of the relative values of steam and electric railway power some of the electrical engineers have frequently given out such an attractive and confident line of loose figures that railway managers and their engineers have often been misled into making recommendations that have later resulted in embarrassment. In fact, references can be made to figures set forth in some of the leading technical journals during the past year that would properly be classified as a "bunch of bull" by competent engineers who have been in active railway service and seen any considerable steam and electric locomotive performances. For example, comparisons have been made, between the operations of new up-to-date electric and of obsolete steam installations; of costs of repairs per locomotive mile for electric and steam locomotives of different dates built new, and of different average ages; and of fuel rates at the sub-stations of modern central power stations with fuel rates of obsolete steam locomotives, per horsepower hour. Also assumptions have been made of extraordinary steam locomotive standby fuel losses; inclusion of steam locomotive tender, but exclusion of electric locomotive non-adhesive weight as non-revenue train tonnage; and of like erroneous factors. It is just as misleading to compare the most efficient electric locomotive operation on the St. Paul with that of its saturated steam locomotives of 1910 as it would be to compare the most efficient superheated steam locomotive performance on the Baltimore & Ohio with that of its electric locomotives.

In line with the foregoing several years ago a report was made on the advisability of electrifying about 275 miles, or a division, of one of the more prominent western lines, and an erroneous comparison was made, first, between the existing antiquated and uneconomical steam and an up-to-date electric operation; and second, by omitting the investment required to bring the steam operation up to date. When all involved factors were properly adjusted the net capital expenditure of $4,000,000 required for electrification compared with $1,000,000 as needed for modernizing the steam equipment, and the estimated annual operating saving of approximately $750,000 from electrification was wiped out and replaced by a saving of $250,000 from a continuation of the improved steam operation.

In view of past experience probably little if any financing of steam road electrification projects in the United States can be undertaken, particularly at present interest on money and labor and material prices, unless the returns are more adequately and fully guaranteed. In fact, few if any existing steam roads can justify or stand the additional capital investment required per mile of road for electrification, except for short distances under very special conditions such as prevailed on the Norfolk & Western, where the ventilation and 1.5 per cent grade line features of a five-eighths mile single track tunnel restricted the train movements to a six mile per hour basis on a congested traffic section of the main line, and even then only providing the fixed charges and operating expenses are not too excessive.

The immediate requirements of new money for the more urgent steam equipment and facilities needed to provide adequate, safe and expeditious rather than luxurious service in the regeneration of the railroads, is the obvious reason for the continued utilization of the over-all more economical steam operation, and only after the possibilities in this direction have been realized can any serious financial consideration be given to the proposed radical change to super-electrification.

First and foremost in the advantages of a continuation of the existing improved steam locomotive for all purposes for which it is permissible, is its flexibility and adaptability to existing railroad trackage and terminal and operating facilities, and the relatively low first cost at which it can be purchased per unit of power developed for the movement of traffic. Being a self-contained mobile power plant, it is possible to quickly transfer needed or surplus power from one part of the line to another and to concentrate it when and where necessary, whereas with the electric locomotive this is impossible unless electrification extends over the entire property or the sources of power supply have almost prohibitive peak load capacity. Furthermore, the various systems of electrification do not make the interchanging of electric locomotives practicable without much non-productive first-cost, complication, and maintenance and operating expense.

As already set forth, special line conditions, as on the Norfolk & Western, may make electrification advisable for short distances, but neither the results on that road nor at the New York terminals justify the frequent reference by electrical engineers to the weakness of steam locomotive haulage during the unprecedented cold weather and volume of traffic conditions during the winter of 1917-18, in that electrification would not have obviated the difficulty. If so, then why did the New Haven not operate at 100 per cent of its capacity, over its electrified zone at that time? If short of locomotives or motor cars the New York Central had plenty of surplus that was not in use and which could not be utilized outside of its electric zone where it was badly needed. The probable answer is lack of interchangeability, which is still one of the most discouraging operating factors involved in any electrification scheme and was fully brought out in the last report of the A. R. A. Committee on Design, Maintenance and Operation of Electric Rolling Stock, wherein the wide variation of current generating, transmitting, distributing and contact systems, voltages, types of locomotives and of general ideas relating to the same sets forth the present undeveloped state of the art.

As the electric locomotive is a constant speed proposition, whether going up or down grade, and is unable to utilize its rated capacity and effectiveness through the same range of speed and tractive power variations as the more flexible steam locomotive, the latter can therefore be more efficiently operated over the continually changing up and down grades, levels, curves and tangents traversed by the average freight train in this country.

It is unquestionably true that when operating under ideal fixed load conditions, the central power station, either hydro-electric or steam, can produce a horsepower with less initial energy input than is possible on a steam locomotive. It is also true that the standby losses on existing steam locomotives are, in ordinary practice, a serious proportion of the total fuel consumption, but it is likewise a fact that the majority of these can be substantially reduced if not entirely overcome, by modernizing the present equipment and improving maintenance and operation, which would then rob the electrical engineers of their main argument in favor of a blanket electrification.

Even though the full steaming capacity, horsepower and drawbar pull of a modern steam locomotive can be developed during cold weather conditions, there are the factors of radiation and freezing to be reckoned with, which gives the electric locomotive the advantage in winter, particularly as its effectiveness is greater on account of the lesser tendency for the motors to overheat. This winter advantage, however, is largely overbalanced during the summer when the main motors heat, especially under overloads, and require cooling at terminals or otherwise overheat and result in insulation breakdowns or burn-outs, or other troubles.

There is no doubt but that the electric has an advantage over the steam locomotive as regards time required for periodical boiler work, fire cleaning and rebuilding, fueling and watering except where fuel oil is used, but where terminal delays occur due to waiting for trains, such as the foregoing statement set forth, the time required for such work does not become an expensive determining factor in the daily average miles to be obtained per locomotive. Also the fact that the electric locomotive cannot, without terminal rest periods, or otherwise the consumption of power to operate auxiliaries, operate at its maximum capacity must not be overlooked. Furthermore, many improvements in the fuel and ash handling and combustion equipment of the steam locomotive using coal are now in process and terminal delays due to these causes are annually being reduced by improved means and methods.

With the establishing of more scientific and careful methods of designing, testing and inspection, and the more extended use of safety appliances, the failures of steam locomotive boilers and machinery, particularly those resulting in personal injury, are relatively low as compared with the work performed. It is therefore doubtful if there is any greater proportion of risk from the steam locomotive in that regard than from electrocution and other attendant dangers from high voltage electrification.

Just as the Interborough Rapid Transit Company has found it possible to bring about a saving of from 15 to 20 per cent in current consumption by means of coasting recorders as a check on the human factor, so can the proper organization and field supervision, checking and education reduce the fuel losses, wastes and consumption of the existing steam locomotives and the increasing cost of coal and oil will no doubt bring about early and extraordinary savings and economies in the direction, from the source of fuel supply to the stack to the end that 1,000 B.t.u.'s of fuel fired will produce more thermal work than ever before.

Abstract of Mr. Armstrong's Address

A. H. Armstrong, Chairman Electrification Committee, General Electric Company, Schenectady, N. Y., followed Mr. Shepherd, and eloquently claimed that owing to handicap of precedent and prejudice, electricity must take up the railway problem where steam leaves off. In other words the proof is up to the electrical engineer proposing any marked departure from commonly accepted standards as established by long years of steam engine railroading. Thus, while a maximum standing load of 60,000 pounds per axle has been generally accepted for steam engines, it is well known that an impact of at least 30 per cent in excess of this figure is delivered to rail and bridges due to unbalanced forces at speed. Impact tests taken on electric locomotives of proper design disclose the feasibility of adopting a materially higher limiting weight per axle than 60,000 pounds without exceeding the destructive effect on track and roadbed now experienced with steam engines. However, owing to the flexibility of electric locomotive design, there is no immediate need of exceeding present steam practice in this respect, although this and other reserves may be called upon in the future.

The electric locomotive has demonstrated its very great advantages in relieving congestion on single track mountain grade divisions. The number of meeting points on a single track line increase as the square of the number of trains operating at one time and proportional to the average speed so that it will be appreciated what an advance in mountain railroading is opened up by the adoption of the electric locomotive. Furthermore, the electric performance as tabulated above can be obtained with each individual locomotive practically regardless of climatic conditions, efficiency of the crew or time that has elapsed since shopping and with a demonstrated reliability that has set a new standard in railroading. In view of the facts, it is a modest claim to make, therefore, that the daily tonnage capacity of single track mountain grade divisions will be increased fully 50 per cent over possible steam engine performance by the adoption of the electric locomotive.

The hazard of mountain operation is greatest on down grades although the perfection of automatic air brakes has done much to modify its dangers. It is left to electricity, however, to add the completing touch to the safe control of descending trains by supplying regenerative electric braking. Not only are air brakes entirely relieved and held in reserve by this device but the potential energy in the descending train is actually converted into electricity which is transmitted through the trolley to the aid of the nearest train demanding power.

Probably in no one respect does the electric locomotive show greater advantage over the steam engine than in cost of maintenance. Special importance attaches to this item of expense in these days of high labor and material costs. In order to draw a fair comparison, however, there should be added to back shop repairs, all expenses of round house, turn table, ash pit, coal and water stations—in fact the many items contributing to rendering necessary steam engine service, as most of these charges are eliminated by the adoption of the electric locomotive. Spare parts can be substituted so quickly that, excepting wrecks, there is no need of the back shop for electric locomotives, unless turning tires and painting may be considered heavy repairs.

The addition of superheaters gives greater output and economy while mechanical stokers add output only and, it is claimed, at some expense in economy over good hand firing. However efficient the power plant on wheels may reasonably be developed without too seriously interfering with the sole purpose of the steam engine, the hauling of trains, it can never approach the fuel economies of modern turbine generating stations. Whatever transmission and conversion losses are interposed between power house and electric locomotives are more than compensated for by the improvement in the load factor resulting from averaging the very fluctuating demands of many individual locomotives.

Every electrical engineer has learned the lesson of the fuel economy resulting from replacing several small and inefficient power stations by one large power house of modern construction. It therefore brings no surprise to his mind that the comparison of steam and electric railway operation discloses such enormous fuel savings in favor of the latter. For as a matter of fact, while our railways carry on a wholesale transportation business of the greatest magnitude, they are nevertheless engaged in burning coal and oil at retail on some 65,000 individual engines. The average output of each engine during the time it is at the call of the transportation department is but a small fraction of its rating. The fuel economy is further affected by the condition of the boiler and climatic conditions. Hence the average performance of many thousands of steam engines must reflect all the many handicaps of construction and service under which they operate.

Each individual electric locomotive will reproduce almost exactly the record of all others in similar service, little influenced by either extreme cold or skill of the engineer, while the fireman so called and still retained, has nothing to do with the matter at all. There is no creeping paralysis gradually impairing the efficiency of an electric locomotive until temporary relief is obtained through frequent boiler washings and round house tinkering inevitably ending up in the major operations annually performed in the back shop hospital on the steam engine to keep it going. It is for such reasons that the electrical engineer is slow to accept general statements of average service operation based on the results of tests usually made on steam engines in excellent condition and skillfully handled. Then, too, there is insufficient data available as to standby losses which must finally largely account for the wide discrepancy often noted between the amount of fuel purchased and fuel presumably burned if computed on the basis of test run records.

Abstract of Mr. Shepherd's Address

F. H. Shepherd, Director of Heavy Traction, Westinghouse Electric & Manufacturing Company, presented a paper showing the notable accomplishments of the electric locomotive, particularly on the Norfolk & Western, and on the Chicago, Milwaukee & St. Paul, and claimed that the advantage of electric power is its great flexibility and mobility. The steam locomotive carries its own plant, while the electric locomotive on the other hand, is simply a transformer of power. The design of the steam locomotive is circumscribed utterly by the necessity of tying up the rest of the machine to a steam boiler. On the other hand, the electric locomotive assembly can differ amazingly as to type, length, axle loading and driving connections. A group of small motors does not differ materially from a single large motor in efficiency. The speed and power, therefore, of an electric locomotive is limited only by conditions of track and construction and condition of car equipment. It thus becomes entirely practicable to build an electric locomotive to take any train which will hold together, over any profile whatever, and at any desired speed. Therefore, it should easily be practical to very greatly increase the speed of our freight trains so that they could all run at a common speed not very different from that at which the superior trains are operated.

Again, with the retirement of the lighter and weaker car equipments, a material increase in the weight of trains will be realized. Without the limitation in train speed commonly accepted as a handicap to operation of tonnage trains, who can say what the limit to train load will be with electric power? In fact, the character of railroad operation which may be secured with electric power has not yet been visualized. Every other industry that has been electrified has experienced a revolution in methods and service due to electrification. This should be equally true in the case of the movement of our railroad traffic.

Our present methods have been built up entirely under the necessities and limitations of the steam locomotive. This is evidenced by the existence of intermediate terminals at the ends of all the so-called engine districts, where all traffic halts. Again, the steam locomotive requires attention en route, needs supplies of water and coal, and, because of its slow movement when hauling our present tonnage trains, it is frequently sidetracked for superior trains, and thus there are more and still more halts to traffic.

Car inspection now takes place at the terminus of each engine district. If, under condition of electric operation, the engine district can be increased to 200, 400 or even 500 miles, is there any good reason why car inspection should not be eliminated at the present intermediate terminals? In fact, is not the general standard of maintenance of equipment of doubtful value on the present basis of inspection at each 100 mile interval? Cars in subway service, which is certainly full of potential hazard, are economically and reliably maintained through inspection at intervals of one to three thousand miles. The elimination of these intermediate terminals, with the resultant necessity of keeping the train moving on the main line, would secure an enormous increase in miles per car with a corresponding saving in equipment.

Furthermore, with the dispatch obtained in handling trains, movement could be so marshalled and scheduled that the necessity of storing goods at terminals to protect exports and local consumption would be largely eliminated, and terminals would then become in fact, as in fiction, gateways open instead of closed.

Coming now to the comparative performance of steam and electric locomotives, it is important to bear in mind their fundamental difference, the one a generator of power and the other a transformer of power. The generation of power in central stations is surrounded with many refinements, and in the consumption of coal there is every opportunity for skillful handling and supervision, so that the thermal efficiency of a modern central station is relatively high and is also continuously maintained. With the steam locomotive, on the other hand, the thermal efficiency is dependent not alone upon the design of the locomotive, but the manner in which it is worked, its condition, which differs widely from the best, and finally by the skill in firing. The electric locomotive, on the other hand, consumes power only when in service and works at any load at its designed efficiency. The average performance, in the case of the electric, approximates the maximum in efficiency, while the steam, on average performance, will differ widely therefrom.

We can therefore hardly expect that with the best steam locomotives the average coal consumption will be equal to twice the coal rate for the same work performed by electric locomotives with steam generated power. Obviously, with hydroelectric generation, the saving in fuel is complete. There is further economy due to the lesser work performed, because the electric locomotive does not have to trail supplies of fuel and water, nor is there need for the hauling of coal to points of local supply, which will always be greater than hauling to electric central stations.

There are a considerable number of different designs of electric locomotives all in successful operation, and each possessing certain advantageous features. Further experience will, undoubtedly, result in the survival of common types for the different classes of service. The great latitude with which electric locomotives can be designed, while fundamentally most desirable, is in itself at the present time somewhat of a handicap. This is now the subject of intensive analysis and this study is undoubtedly developing as well, a better knowledge of the running characteristics of the steam locomotive.

To state the case briefly, we are all interested in the transportation problem. Electrification is bound to be the most potent factor for its relief. We should, therefore, invite and embrace closest cooperation with the engineering and mechanical skill which has been so productive in the steam locomotive field.

Abstract or Mr. Cole's Address

Mr. E. J. Cole, the eminent constructing engineer, after pointing out the slow growth of electric motive power during the twenty-seven years in which it had been in service, cordially admitted that the electrification of terminals, tunnels and certain mountain divisions where water power is available, are now recognized as desirable installations. Among such are the Grand Central terminal and the Pennsylvania entrance in New York City; the Baltimore & Ohio tunnel through Baltimore, the Hoosac tunnel, the Cascade division of the Chicago, Milwaukee & St. Paul railway, and, perhaps, the Elkhorn grade on the Norfolk & Western. Some of these are absolutely necessary regardless of cost.

Then, too, there may be a dozen zones in this country which by reason of density of traffic and co-ordination with the electrified terminals could probably be changed from steam to electric power with profit and the quicker despatch of business. It is a question in my mind, however, whether the best interests of electrical development are served by sweeping generalities and propaganda which have the object of relegating the steam locomotive to the scrap heap, and instilling into the mind of the public how unprofitable, how wasteful and how unsatisfactory is the transportation business when operated by steam locomotives, and recommending as a remedy for some of the ills from which we have been suffering in transportation matters the electrification of the principal roads in this country.

Admittedly, there should be a considerable decrease in fuel consumption for electric operation. The number of tons of coal consumed by railroads of this country for steam operation is a matter of record, but much of the coal which railroads buy is not burned directly in locomotive fireboxes. The heating of shops, office buildings, heating of trains, freight houses, passenger depots, electric current or pumping, and sometimes the fuel burned in steamboats, tugs, etc., (if the railroad company is doing a large business at an ocean terminal) and many other similar purposes have all to be considered.

I doubt very much whether anything like the enormous saving in the consumption of coal is possible, which we have been recently told could be effected if all the railroads in this country were electrified, and I think consideration of all the factors entering into the cost of both methods of transportation will show that one is very much exploited at the expense of the other. Were all the actual figures available of the large installations of railroad electrical power, the results would probably show that the great economy claimed for electrification in the use of fuel has been very much overestimated. The two principal claims to superiority in fuel consumption of the electrical locomotive are due to the fact that more steam per pound can be produced (and obviously produced cheaper) in a power station than in a locomotive boiler, and that while the electric locomotive is not moving, no current need be consumed; whereas with the steam locomotive there are always standby losses which have to be considered, because it is necessary to keep up steam when the locomotive is not in motion, for firing up, radiation losses, etc. A locomotive is a complete, compact and fairly efficient power plant mounted on wheels, which can under the most favorable conditions produce one indicated horse power with less than two pounds of coal. The fluctuating demands for power, however, necessitate working the locomotive, some of the time, under conditions which are not the most economical, but there is a considerable advantage, many times, in having every power unit independent of the other as compared with electric locomotives. Our electrical friends do not dwell much upon this feature, because general tie-ups in the subways and elsewhere from burned-out cables, blow-outs, etc., are annoying and irritating enough to the public without mentioning them in technical literature.

In the paper by Mr. Armstrong with the sensational heading, "The Last Stand of the Reciprocating Steam Engine," read in Schenectady February 20, 1920, it is claimed that the enormous amount of 122,500,000 tons of coal can be saved by electrification of railroads. This means doing the work of the steam locomotive with 30.5 per cent of the present equivalent amount of coal (176,000,000 tons) burned in 1918. These figures are based on tests which assume that locomotives used 7.86 pounds of coal per horsepower-hour, or 10.27 pounds per horsepower at the driver rims. I wish to call attention to two things in this paper:

(a) Not all the coal consumed by railroads is used by locomotives. Shops, power stations, passenger and freight depots, offices and sometimes floating equipment have to be supplied; therefore, deduction must be made from the total amount charged to railroad use. Actual figures from one large railroad show that when winter and summer months are considered, 88.6 per cent is used by locomotives and 11.4 per cent for other purposes of the total coal consumed.

(b) The amount of coal per horsepower of the steam locomotive given in the paper is entirely too high.

Much of the argument is dependent upon the enormous rate he assumes of 7.86 pounds of coal per horsepower. That the coal was only of fair quality, is shown by the analysis of 11,809 b. t. u., but this does not explain why the steam locomotives made the poor showing mentioned in the paper, because the difference between a first-rate grade of coal of, say, 14,500 b. t. u. and that used is only 22 per cent.

The 1,000 gross ton miles unit is generally used for the comparison of operating railroad costs. For electric locomotives the estimated input of current required is 40 watt-hours per ton mile. For coal the estimated amount is 2½ pounds per kilowatt-hour.

The grand total for all regions (229,057 miles) reported in 1918 for steam locomotives is 190.7 pounds of coal, hence the following values per 1,000 gross ton miles: Electric locomotives 40x2½, 100 pounds; and for steam locomotives, 190.7 pounds. These figures include returns from many old locomotives, because it covers nearly the entire railroad system, but if all the engines were new and of modern design, a much better showing could be made.

In 1918 the average cost of coal used by locomotives was $3.49 per ton. The average amount used was 190.7 pounds per 1,000 gross ton miles, so that the cost of fuel was 33.4 cents per 1,000 gross ton miles for steam locomotives over the entire United States. On the Virginian Railroad, where the power is comparatively modern, 163.3 pounds of coal in 1917, and 160.6 pounds in 1919, were used in steam locomotives per 1,000 gross ton miles. The cost of fuel for the same railroad in 1917, 1918, and part of 1919 was from 18.7 cents to 25.9 cents per 1,000 gross ton miles, with coal at $2.38 to $2.74 per ton. On the Norfolk & Western Ry. for 1918 (five months) and the second quarter of 1919, the cost of fuel was 23.3 cents and 26.6 cents per 1,000 gross ton miles with coal at $2.51 and $2.65 per ton. These figures compare very favorably with 28.8 cents for water power.

The cost of electric current for the Baltimore tunnel, years 1910 to 1914, was from $1.049 to $1.435, average $1.199 per 1,000 gross ton miles.

The increasing cost of coal permits the economical use (first cost and maintenance considered) of many fuel saving devices on locomotives at the present time. A few years ago there was not much interest shown in such appliances; therefore, many locomotives are now running which are not so economical as modern engines.

It can be shown by tests made by representatives of the purchasers, builders, and witnessed by disinterested parties, that a Mallet compound locomotive, if in good condition and using superheated steam, in road tests will average 2.14 pounds of dry coal per dynamometer horsepower hour at moderate speeds, mostly on ascending grade. Analysis of coal used in these tests runs about 13,850 b. t. u.; average dry steam per indicated horsepower 21.62. In five tests the minimum was 20.99, and the maximum was 22.33.

Another series of six tests shows an average 3.06 pounds of dry coal per dynamometer horsepower and a thermal efficiency of locomotive 5.69 per cent as a minimum, and 6.25 per cent as a maximum. Taking an average of 3.10 pounds of coal per horsepower, shows that useful work can be done for 39.5 per cent of the coal shown in table III (The Last Stand of the Reciprocating Engine), which gives 7.86 pounds per horsepower. Adding standby losses, variously estimated by competent authorities from 10 to 25 per cent of the fuel burned, but taken at 17.5 per cent leaving 82.5 per cent of the coal to perform useful work, increases the fuel requirement to 3.75 pounds of coal per dynamometer horsepower.

If expressed in electrical units for convenient comparison

$$\frac{3.75 \times 1,000}{746} = 5.05$$

pounds of coal per kilowatt-hour which a modern steam locomotive can produce at the driver rims. This is less than half as much by actual tests as that claimed in table V of the paper referred to. Presumably the figure of 2½ pounds of coal per kilowatt-hour for electrification is not unfavorable to that side of the argument.

Now of this amount, if a kilowatt-hour can be produced at driver rims for 2½ pounds of coal by electrification, and can be produced by steam locomotives for 5.05 pounds, the total amount of coal required by the railroads of the United States, if all were electrified, will not show the great saving claimed in the paper referred to.

The question may be asked whether the figures for coal consumption of steam locomotives fairly represent average conditions on railroads at the present time; perhaps not, but then there is no reason why they could not be made to agree by modernizing such old power worth the expenditure, scrapping others and replacing them with modern locomotives. If electrification were used, then all appliances would be of the latest type and it is fair, therefore, to require that the steam equipment be placed in the same condition.

It seems to the writer that the electric interests have taken an extremely high figure for the amount of coal required in the steam locomotive to produce a horsepower, and, therefore, a correspondingly low total amount of energy required for the electrical operation of the railroad. I am inclined to think that either the coal was of poorer quality than shown by the analysis, or much of it was wasted in passing through the locomotive boiler, perhaps in the form of unburned particles, etc. In any event, it can be shown by many tests which were assisted in and witnessed by disinterested persons, that this figure is probably twice as high as is required when slightly better coal is used and the steam locomotive is in fair condition. The tests I refer to were of sufficient duration, large tonnage trains, and the amount of coal burned was sufficiently great. The tests were duplicated many times with but slight variation. No doubt, while these figures were fairly good, they could in all probability be very much improved if they were intended to make the most favorable showing possible for the steam locomotive. The tests, however, were run under favorable conditions with the equipment in fair operating condition and with loaded trains which varied from about 66 per cent to the full capacity of the locomotives.

It seems to the writer that the relative merit of steam versus electric locomotives is largely one of cost. The railroads have been one of the greatest factors in the development of this country and have served the public fairly well since their introduction about ninety years ago. They have kept up with the improvements quite as well as other branches of engineering work, perhaps more so, since thousands of locomotives have been scrapped, not only because they were worn out and could not be repaired, but because they had proved uneconomical by reason of insufficient weight or capacity to haul the heavy trains now required, or were not equipped with fuel saving devices as are now found on many modern locomotives, such as superheaters, brick arches, compounding, and others, like feed water heating, now coming into use. While some of these features can be added to existing power, it is not generally economical to spend very much money on old, light equipment.

If a correct estimate of energy required to replace a steam engine is taken, in the first instance, it is possible then to estimate with some degree of accuracy the cost of electrification. The number of electric locomotives required, the number of power stations, the overhead construction, or third rail, changes in signaling system, shops and appliances to take care of the electric locomotives and power stations, and the hundred and one items which go to make up a complete installation from steam to electrification, and an estimate of cost made. A balance can be struck between the present cost of steam (which is known with a great deal of accuracy) and the computed cost of operation electrically with interest on capital expenditures at the present high rates. After this is done, the operating costs can be correctly determined.

The reports of electrifications do not give costs of installation, how much is spent in changing over from steam to electricity, so that costs of future electrification may be accurately forecast. This is the question which should be answered—Is it cheaper to operate by steam or by electricity, and can freight per ton mile be moved at less cost (when all expenditures are considered) by electricity than by steam?

The details should not be featured to the exclusion of the whole installation. There are, admittedly, many attractive characteristics of electric power, but when it comes to a wholesale replacement of steam locomotives, especially on roads not peculiarly adapted to electrification, those responsible for the financial returns to the owners and to the public, may well hesitate and ask to be shown the cost, not only of the installation under consideration, but of those now in operation, and the probable return on the investment for the large expenditure they are asked to approve.

Compensation for Curvature on Railways.

The American Railroad Engineering Association has recently deduced a formula whereby the question of reducing the gradient of a line through a curve so that the resistance shall not be unduly great, is much simplified, and from which we extract the following: "The factors which enter into the problem are numerous. The engine will have to overcome resistances due to acceleration. Again, a curve which is only half the length of the train will obviously require less compensation than a similar curve double the length Moreover, a bogie truck (5 ft. centres) will have appreciably less resistance than a driving wheelbase of 13 ft. on an engine, and the curvature resistance of the leading locomotive will be greater than that of the truck it draws, since the latter is being pulled towards the centre of the curve. The principle adopted is to sum up the acceleration, curvature, and gradient resistances, and to ease the gradient where necessary to equalize the work of the locomotive.

Tables are given showing the relation between various curvatures, the resistances in lbs. per ton, and the equivalent gradients, and 2 graphs show the values of the gradient compensation for curve resistances, the selected compensation values being .03, .035, .04 and .05 per cent.

The American Railway Engineering Association accept a compensation of .05 per cent, per degree of curvature in all cases where practicable, .03 per cent where the length of the curve is less than half the longest train length, or where the curve occurs in the first 20 ft. of rise of the gradient, or where the curvature is not a limiting one. They agree to .035 per cent. compensation where the length of the curve is between half and three-quarters that of the longest train, or where the curve occurs between 20 ft. and 40 ft. of rise of the gradient, and .04 per cent. compensation per degree when the curve is operated at low speed, or where its length is greater than the three-quarters that of the longest train, or where the curve is of a limiting value."

Lubrication of Bearings

The *Railway Engineer* claims that the design of bearings for locomotives and other machinery is sometimes based upon the product of pressure in pounds per square inch of projected area and velocity in feet per minute, and various values have been assigned, ranging from 24,000 to 1,720,000. A manufacturer of heavy machinery has limited this value to 60,000 for ordinary lubrication, while 1,100,000 seems to be good practice for locomotive main crank pins. As will be gathered from some of the precautions in design, the bearings that has the best lubrication will last longest, other things being equal. Grit and dirt will often start some scoring, and it may be of interest, in passing, to note that this remedy is sometimes used in current hot boxes. Bearings are occasionally so tightly fitted that little lubricant can enter between the surfaces. Minute oil grooves may then be obtained by introducing a small quantity of powdered emery, which makes circumferential scratches on both the journal and bearing surface. Care should be used in clearing the emery from the lubricant, otherwise abrasion to a serious extent may be caused. Clean bearings, well lubricated and kept in alignment, should give little trouble when properly designed. A writer on this subject recently reviewed the various systems of lubrication in use on locomotive and other engines, and came to the conclusion that mechanical lubrication is the best system inasmuch as it pumps oil to the points of maximum pressure and maintains a perfect film between journal and bearing.

Improvement in Seam Welding

An improvement is claimed by some foreign engineers in the process of seam welding. In the new machine the process is intermittent. Rollers grip the sheets in the usual way, but as soon as the welding current passes and fuses the metal it is switched off and the rollers give the work a squeeze, making a firm weld. After a short interval which gives the weld time to set, the rollers move the work a little, current is switched on, another weld is made, and the same process is repeated. Thus a series of overlapping spot welds is produced, forming a continuous watertight weld. With this machine there is no need to spend time and money in preliminary cleaning of the metals. The series of actions is effected by a simple automatic mechanism. Most successful results have already been achieved by this invention.

Machine Versus Hand-Cut Files

At the present time a large number of men of the new school cannot use a file, and they do not know whether it cuts or not, and so long as it shrieks well they imagine that effective work is being done. Machine-cut files, being cheap, suit this class of man well, for, besides being noisy, they slip over the work easily. Machine-cut files are regularly cut, and for this reason they do not bite the metal, but the best hand-cut file is cut irregularly, with the result that it bites well and does not slide over the surface. The reason for the working superiority of the hand-cut file lies in its irregularity of cutting, while if the old method of working from brass to iron, iron to steel, and finally steel to cast iron is followed, the cost of the hand-cut file worked out in proportion to the superior kind of work done comes to less than that of the machine-cut article.

A New Kind of Coal

The *Scientific Engineer* report that there is a new suggestion as to fuel—a new kind of coal, it is especially timely with coal at the high prices at present obtaining. The idea come from Norway and is the result of experiments carried out in a plant at Greaker, Norway, where an improved process has been employed to produce sulfite coal as a by-product from the manufacture of wood pulp. A ton of wood pulp yields 9 to 10 cubic meters of sulfite lye, of which 95 per cent form other processes. If a new process is generally adopted it is estimated that it will be possible to produce annually sulfite coal equivalent to 800,000 tons of imported coal. Considerable quantities of cheap alcohol are produced from the wood pulp lye before it is made into coal. An essential feature of the new process is high concentration of the lye before removed from the autoclaves.

Steam Pipe Cement

In cases where caulking, plugging, or other mechanical means of stopping leaks cannot be adopted, a cement made by mixing finely pulverized black manganese oxide and raw *linseed* oil into a thick paste will usually be found effective. It should be thoroughly forced into the leak and the pipe should be kept warm enough to absorb or remove the oil from the manganese. In about twenty-four hours the cement should be as hard as the iron, and should adhere thoroughly, so that leakage does not again occur.

To Remove a Tight Nut

Heat an open end wrench which fits the nut to a good heat. While hot place it on the nut, and allow it to remain for a few minutes. The nut will expand under the heat, and may be readily removed with the wrench. If the nut resists this method, it will probably have to be split.

Setting Lathe Tools

For iron set the tool above the center for outside turning, and below the center for boring out. For brass set the tool below the center for outside turning, and above the center for boring out.

Railway Locomotive Engineering

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Solving the Transportation Problem

Amid the clamor for improvements in transportation it is gratifying to hear one clear note of triumph. J. A. Morris, chairman of the Cincinnati Operating Committee, stated before the September meeting of the Cincinnati Railway Club that in the last five or six years the business handled through Cincinnati had increased about 50 per cent. In 1913 and 1914 the movement of cars over the Chesapeake & Ohio bridge ran from 1,000 to 1,900 cars per day. Now it is 3,300 and 3,800 per day. They could handle still more. The reason was the increased efficiency of the yard clerks, conductors, engineers, firemen, yard masters, and, in fact, everyone involved in the railroad business in Cincinnati. Mr. Morris claimed that quite recently the rule was for every road to fight the other road. They would fight all day and not get anywhere. This state of mind has not been amended, it has been abolished altogether. One would think now it was a family of brothers. Some years ago there were about 600 cars of coal a day to be handled and it could not be done. Now they were handling about 1,500 cars of coal per day, with no change in the facilities. Meetings were held; all were eloquent in the things they knew; a peace that passed understanding fell upon the rival railroad workers; they got better acquainted, and, if there is any rivalry now it is in the kindly spirit as to who can help each other the most. Mr. Morris further defied any terminal to show the increase of business handled during the last few years, and they had not yet reached the pinnacle.

As to the effect, it was largely owing to the lack of unity of action in the work of transportation that is causing Detroit, Cleveland, Chicago and other cities to pay $12 to $14 per ton of coal, while Cincinnati is paying $8.50. It is not production, but transportation that is the need of the hour. Mr. Morris concluded by claiming that the future of the railroads is a personal matter—on it hangs the prosperity of our country, the ultimate route for the reduction of the high cost of living.

Use of the Pyrometer on the Locomotive.

There are so many attachments on the modern high-powered locomotive that it has become difficult to secure even a limited degree of opportunity to add any more, no matter how meritorious the new appliance may be, or how necessary its operation may be to obtain that degree of perfection in economy and maintenance which is essential to the highest degree of performance. This is particularly true of the application of the pyrometer to the locomotive equipped with superheating apparatus. With the advent of the superheater the particular merits of which were immediately recognized, the pyrometer should have come hand in hand with the meritorious appliance. Its slow introduction reminds us of the early practice before the advent of the safety valve, the engines were furnished with a crude appliance whereby the engineer could open a valve and obtain a vague impression from the issuing blast of steam what amount of pressure the boiler was generating at the moment of release. True, the engineer had the performance of the engine as a general guide, but in the variations of the work to be done by engines generally and locomotives particularly, this was not always a sure guide. The safety valve, if properly adjusted, may be looked upon as reliable. Not only so, but its automatic action of the device relieves the engineer of any manipulation in regard to its operation, and a momentary glance at the steam gauge furnishes all the information desired in regard to diminishing or increasing pressure.

So it is with the pyrometer. It adds nothing to the engineer's work, but is a certain guide as to whether the superheater appliance is furnishing the full quota of added work of which it is capable. Without the pyrometer the engineer is more or less in the dark. A defect in the performance is not always instantly detected. The incidental variations in the tractive power necessary to negotiate curves and grades are not past finding out, but it is impossible to determine whether the superheating apparatus is in full operation without the use of the pyrometer.

As is well known there are a large number of causes that are detrimental to obtaining the highest degree of superheated steam. The water in the boiler may be too high, in which case the increased saturation of the steam passing into the superheater pipes retards the action of the expansion of the volume of steam, a leak in the front end admitting the outer air, having nearly the same effect on the thin pipes as a spray of cold water in lowering the temperature of the superheated steam; the plugging up of flues, the damper remaining closed on account of some mechanical defect, the clogging of the netting, the accumulation of boiler scale, the improper adjustment of the exhaust nozzle and other minor defects all tend to a lessening of the efficiency of the superheater appliance, and while all these defects may be readily remedied they are not all immediately apprehended, and much loss of fuel and efficiency in operation is occasioned.

With the use of the pyrometer the temperature of the steam is known instantly and positively. The device is simple, cheap and durable. What is known as the thermo-couples are generally installed in the steam pipes or the steam chests. The action of the thermo-couples is such that an electric current proportionate to the difference in temperature between the hot and cold junctures of the couple is generated. The indicator itself contains a millivolt meter actuated by the current generated at the thermo-couple and moves a pointer on the dial indicating the actual temperature of the steam. It will thus be seen that the pyrometer equipment for a locomotive consists of three parts; a steam fixture containing the hot junction of the thermo-couple, which is screwed into the steam-chest or steam pipe of the engine; a cable connecting the fixture in the steam-chest or steam pipe to the indicator; the latter being securely attached in the cab. The hot junction of the thermo-couple is directly exposed to the flow of superheated steam, the cold junction of the thermo-couple being at atmospheric temperature the variations of the atmospheric temperature being compensated for, and a current being thereby generated and the slightest variation in the temperature of the steam immediately affecting the current generated, the exact temperature being immediately shown upon the dial of the indicator in the cab.

In operation when the locomotive is started it will be noted that, assuming that the boiler pressure is 200 lbs., the indicator of the pyrometer, located at the left-hand side of the dial, will show a reading of 350 lbs. or more. When the superheater appliances become operative the pointer will move from left to right on the scale, showing an increase of temperature on the steam-chest until the indicator dial registers between 600 and 650 degrees, indicating that the maximum saving that the superheater makes available is being obtained. If it fails to approach the figures referred to it is proof that the locomotive is not being operated to produce the best results or that there is some defect of the kind that we have already referred to counteracting the full efficiency of the superheater appliance.

The defect, of course, is a matter requiring investigation, and while the engineer may not have time to locate the defect, or even the means or ability to apply a remedy, a reliable warning is being given by the indicator dial, so that the matter should be reported and a thorough examination made, and it is not unreasonable to presume that the skilled mechanics in the roundhouse will discover the cause and apply the remedy to the end that the loss occasioned by the lack of the full use of the superheater may not be continued.

The Testing of Metals.

Recent advantages in the construction of X-ray tubes, with corresponding improvements in the apparatus for the production of the necessary high-tension current, have made it possible to examine the internal structure of steel plates and castings, as well as of less dense material such as aluminum and wood. At present, thicknesses of ferrous metals up to 2 inches have been successfully radiographed, and regular advances are being made in the subject, so that its scope is constantly increasing. It will be apparent to everyone after a little thought that the testing of materials, which is so necessary for the successful production of reliable castings and forgings might be rendered more efficient by the process. For example a cylinder or other casting may appear from external observation a perfect specimen, but under the X-ray flaws and blow-holes show up clearly; small standpipes and welded joints may also be radiographed, and defective flaws detected. Considerable use may also be made of the rays in detecting lack of homogeneity in alloys, uneven distribution of a constituent showing plainly as a patchy structure in a radiograph. In many instances the quality of material and workmanship of the inner layers cannot be ascertained by the usual methods which have hitherto been in vogue the whole tending to the attainment of that approach to perfection, which may be classed as Shakespeare says to "a consummation devoutly to be wished for."

A Good Suggestion for Economy.

We heartily endorse a wise thought recently brought to the attention of the employes of the Northern Pacific Railway Company by Mr. Howard Elliott, chairman of the Board of Directors, who said:

"Suppose that the 2,000,000 men in the railroad service, from the water boy on the extra gang to the highest executive, could save 5 cents a day, by greater and more intelligent effort, by greater care of plant, materials and fuel, by the elimination of waste, and the adoption of improved methods, the total saving would be $30,000,000 for a 300 work-day year. This is enough to buy 400 heavy locomotives, or 10,000 freight cars. Suppose only an average of one hour a day could be saved by shippers in loading and unloading the 2,400,000 freight cars; this time for a 300 work-day year would be 720,000,000 car hours, or 30,000,000 car days, or 100,000 cars per year added to the available supply of the country without the investment of new capital. Now it is necessary for all good citizens, whether in or out of railroad service, to obey the new transportation law in spirit and letter and to work and save day in and day out, until the wastage of the war is made good and the transportation system brought back more nearly in keeping with the needs of the country."

New Tunnel Under the Hudson River.

Amid much ceremony among State and city officials, ground has been broken marking the beginning of the construction of a twin-tube thoroughfare which will join New York and Jersey City beneath the river. October 12, Columbus Day, was selected for the occasion, and as the engineering plans have been perfected, and as the State assemblies of New York and New Jersey have agreed on the appropriation, real work may be said to have begun. The estimated cost is fifty-seven million dollars, but like the Panama Canal those who live to see it finished will know better about the final cost than we know now. If it is not nearly double it will show some real progress in engineering estimates. In any event it will be a great relief to traffic generally, and to the admission of coal during the severe winters which we have almost always with us. The apprehension that the tubes will destroy the ferry traffic is groundless, because at the rate of increase of population—about three hundred thousand yearly in New York City alone—the population will likely be doubled before the double tubes are in operation. At the end of twenty years it is claimed that each State will have over thirty millions profit. If our opinion is worth anything, unless politicians generally and financiers particularly change their ways, the States will have much less.

Fatigue

There are at least four successive degrees of fatigue. First, there is the fatigue caused by any movement, however small. This can be overcome by a very slight pause, which leaves the muscle ready for further action. A very good example of this is found in the beating of the heart. There is just enough pause between the beats for the muscle to recover, and so the heart beats without a rest for an average of 65 years. The next stage is where motion cannot be continued for long, but a very short rest enables the muscle to continue, with this difference from the first case, that there is here a cumulative effect of fatigue, and the operator must have a complete rest at the end of a "spell" of work. An example of this class would be the swinging of a sledge hammer, where the man pauses between each blow.

The third stage is the accumulation of fatigue which the rest at the end of the spell will not dissipate, and which demands a night's sleep to eliminate it. The fourth stage, which ought never to be reached, is when the night's rest does not restore the body to its normal condition and there is an accumulation of fatigue from day to day resulting, finally, in a "run down" condition or in disease.

From what has been said it will be seen that fatigue is always increasing, and that the more "latent" fatigue a man has, the more will fatigue affect him. The chief application of these elementary facts to an engineering works lie in the problem of overtime or holidays. To work too long without holidays causes a permanent staleness which the night's rest alone will not dispel. That is the chief justification, on medical grounds, of the week-end holiday.

With regard to the problem of overtime, it will be seen that it is better to work at the beginning of the week when the system is free than at the end of the week when the worker has lost his freshness. Thus the custom, prevalent in many parts of the country, of not working overtime on Friday has more to recommend it than the facility given to an employe to spend his wages or to hurry home to his wife in time for her to do so.

British Inventors Waking Up

A writer in the British *Nineteenth Century*, writing on the "Power of Tomorrow," looks cheerfully to the day when all our electric power stations will be useless except for museum purposes. Power will be got directly from sunshine. Meanwhile Sir Charles Parsons, the inventor of the turbine, is renewing his suggestion that by digging a hole in the earth eighty miles deep an unlimited source of power will be discovered. Neither say how they will harness the power.

Snap Shots—By The Wanderer

When Louis Brandeis made his celebrated assertion that, if efficiently managed the railroads of the country could save one million dollars a day as compared with their outlay at the time, he was laughed out of court by the railroad fraternity as a man who talks of things of which he knows nothing, and was asked to show how. This he utterly failed to do, but he struck a popular chord in his attack upon railroad management, and for that and for other services to the administration of a more personal nature, rumor has it that he was rewarded by a seat on the supreme court bench.

A million dollars a day is quite a snug little sum, and yet I sometimes wonder how much Brandeis was really out of the way.

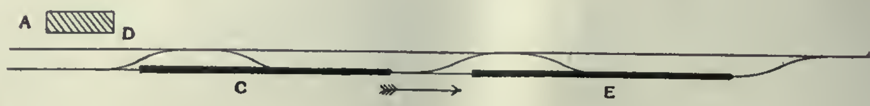
It happened that I recently had occasion to hang around the shop and yards of a big system. A system that has grown in a few years from "a streak of rust and a right-of-way" to something really big and imposing. And here is a truthful narrative of a few little things that were thrust under my nose.

An engine had pulled to the yard ladder track and for lack of room had been left there by the crew and the hostler had taken charge. I boarded the engine about a half hour later and found a heavier fire than should have been on the grates at any point on the run. On my remarking it, the foreman agreed and said that there was coal enough there to run ten miles. Whereupon he started to pull the train into the yard, telling his fireman to run the stoker and clear it as the fire had to be dumped. So the fireman started. As soon as the conveyor worm had cleared the hopper, he shoveled about 200 lbs. of coal into it. I asked why, and he said "he had to fill the hole." Then he started hand firing and before we had gone a train length (50 cars) he had put in 30 big shovelfuls of coal so that the firebox was then heaped up to a level bed flush with the bottom of the firing door. There was considerably more than a ton of coal in that firebox. More than there should have been when the engine was uncoupled, and ten minutes later the whole glowing mass was dumped into the ash pit. And the coal cost about $4.00 a ton.

And right there, or nearby, I stumbled into a fine example, a little one, to be sure, but a fine example of the lack of interdepartmental courtesy and consideration. Two men of the motive power department were pushing a lorrey car loaded with some material for the engine of heavy fire fame. They came to a switch where the roadmaster was at work with a gang of men. I could see that it was a rush job and so made no comment when a man with a wrench failed to move his foot so that the lorrey could pass. But when an unengaged portion of the gang put another lorrey on the track directly in the way of my men I protested and was curtly told to talk to the boss, which I did, and was told that they, too, were going to the shop "pretty soon!" That pretty soon was fifteen minutes. Had they allowed us to pass first they would have been delayed a possible fifteen seconds. So here is my accounting of the transaction: They delayed us fifteen minutes, which, multiplied by two men, equals thirty man minutes of time lost to the company. We would have delayed them fifteen seconds, which, multiplied by their four men, would have equalled one man minute. So that the failure of the roadmaster to exercise a little departmental courtesy and consideration cost his company the labor of a man for twenty-nine minutes.

Then, later, I was on the engine of heavy fire. We were going over a division of something less than 150 miles and were following another freight train that had a starting lead of about forty-five minutes. It was a double track with a neck of single track about fifty miles from the terminal. When we reached the place the train ahead was on a siding where it had run in for a meet. The conductor had asked to be allowed to stand at the rear end, but had been ordered to the front. It was like this:

The telegraph office was at A at the end of the double track, and the single track was about ten miles long. Just beyond the end of the double track was a long passing siding and the leading train (E) was moved to the far end of it although the conductor asked to be put at the rear end. And that was where the trouble began. There was an allowance of forty-five minutes on a following passenger train, running special for a public functionary, giving ample time for both freights to reach passing sidings at the other end of the single track. But seniority rights would not permit the second train to run around the first and the first was out of reach, so both waited for the following passenger train. Then came waits to meet passenger trains and the waits kept up until both trains had been held on that siding for five hours and a half. If we place the value and the cost of delaying those trains at $25.00 an hour we have a cost of $275.00 to the railroad company with nothing to show for it. To the layman the solution appears easy. Why not run train C past E, and let C deliver orders to E. Or hold up the special long enough to send a messenger to train E, which would be ten minutes; or not start C from the terminal with such a possible congestion ahead of it.



The question is whether the time of the public functionary was worth $27.50 a minute to the country when he was asleep in bed in the middle of the night. It may have been good despatching that, but it certainly was mighty poor business, which was emphasized by the fact that that five hours of the delay had to be paid for in overtime.

And this brings to mind the suggestion so often made that an executive could well afford to employ a traveling inspector to stop such leaks as these. Of course, the usefulness of a representative of the executive to look after and check off such matters would depend on the way he worked. It would be a delicate task and one calling for a great tact. It would not do at all for him merely to report failings to headquarters and then let headquarters sail into the men with calls to order and demands for the reason why. Under such a regime, the official life and usefulness of the representative would indeed be short-lived. He would be looked upon as a telltale and a nuisance and things would be as skillfully concealed from him as though located on the other side of the moon. But, most men in responsibility on railroads, no matter how small that responsibility may be, are anxious to make a showing, and it would only need that the tactful representative call their attention to the slips and wastes to secure an immediate response and a hearty effort to improve conditions. That this is so is evidenced by the great mass of shop kinks which have come into being in the railroad shops of the country, under conditions not of encouragement but often of actual discouragement, and despite the most adverse of working conditions. At any rate, after a careful selection of the man such an one ought to be able to pay big dividends on his salary. But there the difficulty appears. No bookkeeping, no records, no reports would show or hint at the savings he affected. It would be like the saving the cost of a collision that did not occur, because of the installation of expensive signals. Everybody believes millions to be saved, but without any positive proof of that effect.

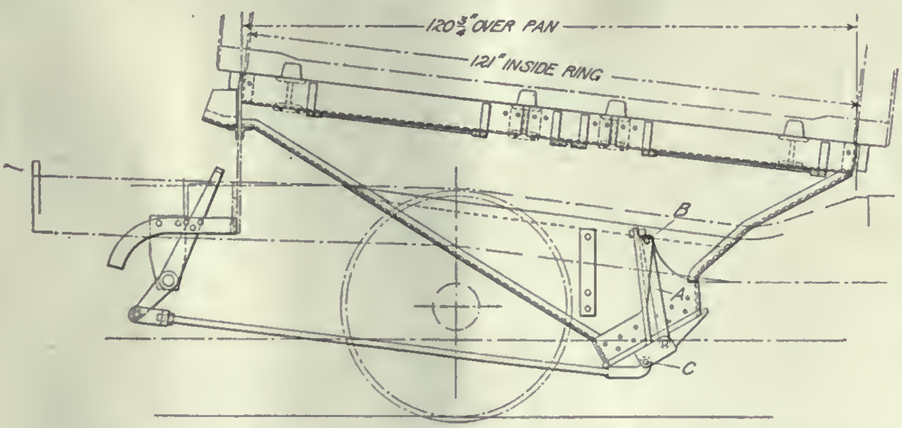
Mountain Type of Locomotive for the New York, New Haven & Hartford Railroad

The American Locomotive Co. have recently completed an order for thirty mountain type (4-8-2) locomotives for the New York, New Haven and Hartford R. R., a reproduction of a photograph of one of these engines being presented herewith.

4-8-2 TYPE LOCOMOTIVE FOR THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD
AMERICAN LOCOMOTIVE COMPANY, BUILDERS

The engines have been designed with the view of applying certain devices to all of them, if these same devices should prove of value on those to which they have been applied. For example, five of the engines have been fitted with the feed water heater made by the Locomotive Feed Water Heater Co. and the arrangement of running boards, air pumps and similarly located parts has been kept uniform on all of the engines, so that the feed water heater can be applied to any or all of the others, provided experience with it on the five proves such an application to be desirable.

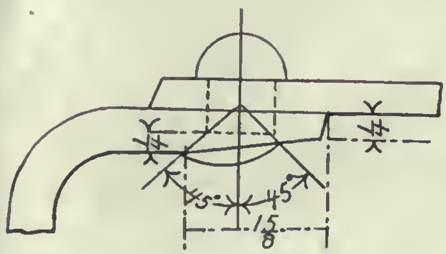
The advent of the booster engine and gear, while still in a more or less experimental state places it in a position to be considered in locomotive design. Hence the trailing axle has been arranged so that booster gears can be applied without the necessity of making a new axle. This also applies to the trailing truck and the brake used upon it.



DETAILS OF SINGLE HOPPER ASHPAN AND IMPROVED DOOR

The Southern valve gear is used with the Lewis reverse gear and the Duplex stoker.

Among the details of construction attention is called to the single hopper ash pan and door. This door is a modification of the Beale door that was the standard on the New York, Ontario & Western Ry. for many years, but which had but few other applications during the life of the patent. The essential feature of the door lies in its being suspended at its center by a link (A) whose pivotal point (B) is off center. So that, if the door were to swing evenly with the link the first movement on opening would be away from the face of the hopper. But it will not swing evenly with the link. It will be noticed that the connection (C) of the operating rod is below the point of suspension of the door on the link. The result is that when there is a thrust on the connection to open the door the first swinging movement of the link is to move the door away from the hopper, and then the thrust of the connection tends to tilt the door and makes it swing up out of the way in front of the hopper. It is a very simple arrangement and one that will not stick or jam and leaves a free opening for the flow of ashes out of the hopper.



FIRE BOX SEAM USED ON MOUNTAIN TYPE LOCOMOTIVE

The boiler is fitted with a combustion chamber and one of the details of its construction and that of the firebox is the method of scarfing the lap sheet on the fire side of the seam. This is shown in the accompanying engraving. The sheet, which is ½ in. thick, carries its full thickness up to 1⅝ in. from the edge. Here a line drawn from the intersection of center line of the rivet hole and the contact face of the two sheets at an angle of forty-five degrees with the center line of the rivet, will strike the surface. From this point the face of the sheet is beveled to a thickness of ¼ in. at the edge of the sheet. The rivet hole is then countersunk at an angle of 45 degrees on each side down to within ¼ in. of the contact face of the sheet. This gives a minimum of thickness of metal exposed to the fire and a substantial seam and holding power for the rivet.

The engines weigh 328,500 lbs. in working order, of which 229,000 lbs. are upon the driving wheels. With a tractive effect of 53,900 lbs. the factor of adhesion becomes 4.25. The balance of the weight is so distributed that 47,000 lbs. are upon the front truck and 52,500 lbs. are upon the trailer. The front truck is of the constant resistance type of the Woodward design. The rear truck is the Commonwealth and is practically a modification of the old pony or Bissel truck.

The following are some of the principal dimensions of the engines in addition to such details of construction as have already been described and specified:

Cylinder diameter, 27 in.; piston stroke, 30 in.; driving wheel base, 18 ft. 3 in.; total engine wheel base, 40 ft. 0 in.; total engine and tender wheel base, 75 ft. 7½ in.; inside diameter, first boiler ring, 76½ in.; steam pressure, 200 lbs.; width of firebox, 84¼ in.; length of firebox, 120⅛ in.; length of combustion chamber, 60 in.; radial crown staying—tubes, number 216; tubes, diameter, 2¼ in.; tubes, material, charcoal iron; flues, number, 40; flues, diameter, 5½ in.; flues, material, seamless steel; tubes, length, 20 ft. 6 in.; tubes, spacing, 11/16 in. Heating surface—Tubes, 2,597 sq. ft.; flues, 1,176 sq. ft.; firebox, 320 sq. ft.; arch tubes, 28 sq. ft.; total, 4,121 sq. ft. Superheater surface, 1,009 sq. ft.; grate area, 70.3 sq. ft.; diam. driving wheels, 69 in.; diam. front truck wheels, 33 in.; diam. trailing truck wheels, 43 in.; main axle journals, 12 in. x 13 in.; trailing driver axle journals, 10 in. x 13 in.; front truck axle journals, 6½ in. x 12 in.; trailing truck axle journals, 9 in. x 14 in.; air pump, 8½ in. Cross compound; piston rod diam., 4¾ in.; smoke stack diam., 18 in.; smoke stack above rail, 15 ft. 0 in.; tank water capacity, 10,000 gals.; tank coal capacity, 16 tons; valves, type, 14 in. piston; valves, travel, 7 in.; valves, outside lap, 1¼ in.; valves, clearance, 3/16 in.; valves, lead in full gear, ¼ in.

Improved Means and Methods of Testing Welds

During the last four or five years the testing of welds has come under the consideration of scientific experts and valuable results have been obtained. Among the most recent contributions on the subject a paper read before the September meeting of the Chicago Section of the American Welding Society by S. W. Miller, M. E., proprietor of the Rochester Welding Works, an eminent authority on autogenous welding, attracted keen attention, and some abstracts from Mr. Miller's paper should be of interest, particularly to those engaged in the work. The author of the paper stated that the usual test is the tensile that gives the tensile strength per square inch, the yield or elastic limit in pounds per square inch, the elongation in per cent of the original gauge length and the reduction of area in per cent of the original section. Compression, torsion, shock and alternating stress tests are also used and the two latter are beginning to be used much more than they have in the past because it has been found that materials may give high results in the tensile test and yet be entirely unsuitable to resist service where shock or alternating stresses are met. Another of the common tests is bending to a certain radius either hot or cold and it has been found that it is a very valuable test of certain qualities.

The microscope has been found to be of tremendous help in the study of metals and in fact it is now a necessary instrument in all laboratories. Its principal function is to determine the extent and location of impurities in a metal, to decide whether the structure is proper for the purpose desired and to decide whether various heat treatments will give satisfactory results. While no one method of test shows everything desired to be known, the microscope is probably the most powerful single method of investigation in the case of metals, and in the study of welds it is particularly valuable because of the method of their formation. A weld is a casting and is subject to all the defects found in castings which are, however, exaggerated in the case of welds. It is not forgotten that welds of inferior quality may answer some purposes admirably and that if they do, there is no use in making better ones, but this is not the goal at which to aim for one who desires to make really good welds. The welding of steel is frequently considered as not being especially difficult and it is also sometimes considered that steel is steel and that no different treatment is required in the case of different qualities and varieties of steel. This idea is much less common today than it was several years ago, but it is still too prevalent for the good of the art. It is not as well known as it should be that a comparatively small difference in the percentage of carbon in the material being welded makes a very great difference in the results of either a bend or tensile test. If the carbon is .12 per cent or less, the material is soft, ductile and yield readily to any strain that may be put on it. Such material is frequently used for tanks and because of its ductility and comparative freedom from damage by heating, is admirably suited for welding. Structural steel, bar steel and boiler plate contain about .15 per cent to .25 per cent carbon and have a tensile strength of about 60,000 lbs., while the soft low carbon material has only about 52,000 to 55,000. Ship plate is required to have a T. S. of from 58,000 to 68,000 lbs. and in the heavier sections requires as high as .30 per cent carbon. It has been found by experience that the higher the carbon, the more difficult it is to get a satisfactory weld and the more danger there is of injuring the metal being welded. From a metallurgical point of view this is entirely natural and to be expected. It is also evident that a weld made with a given welding rod or electrode can have only a given strength. If this strength is greater than that of the material being welded, the test piece will always break outside of the weld. If, on the other the rupture will occur outside the weld when the section of the weld is the same as the section of the piece, so that in making tests of welded pieces, it is necessary to know accurately the character of the material being welded because if Welder Jones makes a weld in soft tank steel and Smith makes one in bar steel the first will break outside of the weld and the latter in the weld with a probable adverse criticism of Smith's work. The method of test to be applied in any given case depends largely on the use to which the welded piece is to be put. There are no standards at present for weld tests, and inasmuch as a welded piece is not of uniform character it is not possible to use the elongation and reduction of area as commonly measured. When the break is outside the weld the various physical characteristics are those of the original material and not at all of the weld. The best test, in my opinion, to determine quickly the general character of a weld, is to grind it off level with the surface of the pieces and clamp it on an anvil, with the center of the weld level with the top of the anvil, the bottom of the V toward the anvil so that the top of the weld is stretched when the projecting end is struck with a sledge. The blow should not be too heavy and the number of blows and angle to which the piece bends before cracking are quite a good index of the value of the weld. It is true in this test, as in the tensile tests, that the quality of the material being welded has a great influence on the results. Stiff material throwing more of the strain into the weld while soft ductile material will itself take considerable of the bend. In the case of defective welds, that is, those not fused along the V or which contain slag or other inclusions, this test will at once develop the defects. If a welded piece were to be used in a place where it might become red hot such as, for instance, in a locomotive fire box crown sheet, it would be entirely proper to test the weld at a good red heat and I believe that it would be of much interest to all of you, if you would test some of your welds by clamping them in a heavy vise or on an anvil with the center of the weld about half an inch from the edge of the table or above the face of the anvil, heating them to a bright orange with the torch and then bending them as before as with a sledge.

If such welds are made in half inch by two inch bar steel, a 90 degree single V being used, and they bend to a right angle cold without cracking on the outside, a welder may feel well satisfied with his work.

There has recently been developed a method for testing rails for these hidden defects which has been devised by Mr. A. M. Waring. It consists of deeply etching a polished surface of the material under test. For instance, a section of a weld might be cut out with a hack saw, machined or filed to a true surface, and polished on various grades of emery paper, ending up with 00 Manning. It is then placed in a warm solution of 25 per cent hydrochloric acid and water for from a half hour to an hour. The acid will eat away the defects, making the edges of the material at them taper, so that rather large grooves and pits will be visible where the defects prior to the etching would be only microscopic. It is not really necessary to warm the acid although it takes longer when it is cold. The bending test hot and cold and the etching test I consider to be of the greatest value in ordinary shop practice where it is desired to find out rapidly and quite accurately what the quality of the work done by the different welders is.

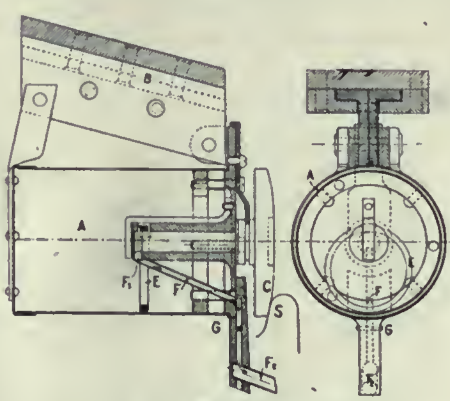
A great deal may be learned from the appearance of a weld. It is difficult to describe the appearance of good welds but after they have been seen a number of times, an inspector can readily say whether the operator knows what he is doing. In gas welding, I would not accept a ripple weld in heavy material nor one which was narrower than about 2½ times the thickness of the sheet, because I have never seen a weld having these appearances that was properly welded. The appearance in a gas weld of porosities on top, indicates that the metal has been overheated, and the same thing is true in an electric weld. Inasmuch as I believe that the serious defects in welds are caused by oxides, it would appear wise in the case of gas welding to use no larger tip than is necessary to produce thorough fusion. This means that the catalogue speeds of welding are impossible if good welds are desired. The same thing is true of electric welds. The reason is that at the high temperatures of the steel caused by too large a tip or too heavy a current, the metal becomes overheated, and in that condition combines more readily with the oxygen of the air or with any excess oxygen in the torch flame, and produces oxides which are readily dissolved by the melted metal. As the metal cools down, these oxides are rejected in large part and pass to the grain boundaries, as do other impurities, so that it is perfectly natural that material which has been seriously overheated should be more brittle and weaker than the material which has been properly melted. In conclusion, I have found in a number of cases that very great improvements in the quality of the work were made by using regularly the bending test above described and by carefully instructing the welders until they were able to make welds that would meet this test with unfailing regularity.

Montreux-Oberland Automatic Flange Lubricator

Mr. Zehuder-Sporry, manager of the Montreux-Oberland Railway, has designed and placed a flange lubricator in service on a number of the motor cars of that road.

It conssits of an oil reservoir A suspended to a slide moving in an inclined guide B fastened to the frame of the truck. As a result of this inclination of the guide the roller C of the apparatus is always pressed against the top of the flange S of the wheel, which, in turn, communicates a continuous rotary motion to the roller. The shaft of this roller carries an oiling ring E, in the oil reservoir, which drops down into the oil. As a result of the rotation of C the oiling ring works and the oil, carried up by it, flows drop by drop into the conduits F_1 and F_2 to fall from the latter upon the flange. This flow can be regulated by the little cock G. The apparatus is well arranged, it follows all of the lateral movements of the wheel and delivers oil only when it turns, and places the drop of oil just where it is needed. The discharge of oil is very slight and it is only necessary to fill the apparatus every eight or ten days, and waste oil is used that is unsuited for any other purpose.

On the Montreux-Oberland Railway, out of 200 passengers cars it has been found to be sufficient to equip three motor cars with two apparatus, one on each side, to obtain, on a line 46 miles long, a permanent lubrication of the sides of the rails. The reservoir holds 1.8 quarts and 1.6 quarts will serve for a run of 1,000 miles, or 3.2 quarts for 1,000 car miles. The maximum speed at which these cars are run is 27 miles per hour. There are numerous short curves ranging in radius from 130 ft. to 260 ft. Before the use of this lubrication it is stated that, besides the wear on the tire, the wear of the rail amounted to 20 per cent. of the width of the head at the end of 6 or 8 years, when it was necessary to renew the rails. This method of lubrication has almost entirely stopped this wear. As for the tires, their previous life was about 48,000 miles, whereas now it is about 120,000 miles.



DETAILS OF MONTREUX-OBERLAND FLANGE LUBRICATION

Finally, without having any definite information as the result of tests, it is the impression that the hauling resistance is less.

Hammer Shafts.

Hammer shafts or handles should bear some proportion to the weight of this tool and the use to which it is put. The following is a good guide to selection. For hand hammers weighing from ¾ lb. to 1½ lb. the length should be 14 in., and then up to 2 lb., 16 in. Riveting hammers should have 24 in. shafts; smiths' flogging hammers up to about 7 lb. require 30 in., and up to 14 lb. 36 in., while above this from 40 in. to 42 in. becomes desirable. In every case the heads should be firmly and securely fixed.

Removing Broken Studs

Assuming that a stud is broken in a screwed hole, if a thin lubricant is applied, such as paraffine and light engine oil mixed, in a few hours the lubricant will soak to the bottom, and as far as possible make removal easy. If from this stage a hole about half the diameter of the stud is drilled with a flat drill with the cut reversed, or "left-handed," it will usually be found that the vibration will loosen the thread and the drill will turn the stud instead of cutting its way into the metal.

Completion of the Hudson Bay Railway

The earthworks, bridges and many of the station buildings have been completed, and 92 miles of track remain to be laid. As a grain exporting port, Port Nelson could be used for the grain sent from Saskatoon to Liverpool, the rail journey being shortened from 1,489 to 697 miles, and the sea journey from 3,359 to 2,966 miles, as compared with the transmission via Montreal. With an open route for 3 months annually 30 million bushels of grain could be shipped every year to Europe, with a saving of 15 cents per bushel. On this railway an efficient system of lighting and fog signaling at Hudson straits will be necessary.

Suggestions for Greater Economy in the Repair and Maintenance of Steam Locomotives

By M. A. BLAIR, Instructor, Detroit Technical Institute

INTRODUCTION

With a view of aiding in the good work of improving the condition of the railroads in so far as the mechanical department is concerned, we begin the publication of a series of papers by a mechanical expert who, in addition to a wide experience possesses the faculty of keen observation, superadded to the rare faculty of suggesting improvements in detail of construction and repair. It is easy to find fault. It is also easy to suggest vast improvements in the way of procuring the best means and methods obtainable, but to get along in the best possible way with what we have at hand is better. These papers will be an effort to point out some of the changes for improvement that are possible in the mechanical department. The efficiency of a railroad depends upon that of the mechanical department. The best possible use of power by the transportation department cannot neutralize the ill effects resultant from the misuse of it in the mechanical department. Good supervision is required to avoid this. In order to have good supervision, a thorough knowledge of the work as it is performed is necessary. Many railroad officials have not been in close touch with the work for several years and the business has, to a degree, grown away from them. Possibly these papers will direct their attention to sources of waste and suggest ways of improvement.

Some of the principal causes of waste are discussed. In no case are these rare occurrences, but are the daily practice and conditions, some of which are to be found on every railroad in the United States. The material has been taken directly from the shops and terminals of different railroads. A repetition of subjects, or the manner in which subjects have been treated by others has been avoided. After reading these papers an official may investigate his department and find few of the leaks mentioned—but he will find many other things equally as wasteful, which he did not know. He certainly will find things he can better if he makes an effort. In this case these papers will be of as much value as though he found exactly what is mentioned. Their chief value may be in that one effect: The promotion of thought and investigation.

A review of what is considered settled and incapable of improvement may result in much good. What was the proper thing a few years ago may not be the proper thing today. No official is averse to improvement in service from power at the same cost, or the same service at a lower cost. These papers will advocate an improved service at a lower cost. The high cost of transportation to the railroad companies should be a strong incentive to strive for the greatest possible efficiency.

If we admit that things will not be allowed to continue as they are, it at once suggests another thought: A higher standard of management will be demanded of railroad officials in the near future, and the merits that enabled many men to hold certain positions in the past five years will not enable them to hold the same positions in the next five. If railroading is worth doing at all it is worth doing well.

THE LOCOMOTIVE IN THE ROUNDHOUSE

The ideal locomotive would be an engine, that besides other qualities, would require no work in the roundhouse; it would cost nothing for repairs and as soon as one crew finished a trip, the engine could be supplied with fuel and water and resume its work. It is not necessary to state that such an engine is an impossibility, But, we may approach or recede, from this high degree of efficiency in locomotive maintenance. The results we get will be governed by the use that is made of the engine, and the manner in which it is handled in back shops and roundhouses.

The value of a locomotive is determined by its net earning power, this in turn by the number of hours of a year it can draw its rated tonnage at an economical speed, and the operation and maintenance cost. The popular belief among railroad men is: A locomotive requires a great amount of work in roundhouses. It makes no difference what breakdowns or failures occur, what work is necessary, or how long an engine is out of service due to this work; it is accepted as a natural and inevitable consequence of locomotive operation. But is it?

We will assume an engine having received first-class repairs in the back shop; Fire box, flues, boiler, boiler fittings, dry pipe, steam pipes, and super-heater units in good condition, cylinders and valve bushings rebored if necessary, new pistons, valves and rings, piston and valve rods turned and packing and cups to fit rods. Journals and crank pins turned if necessary; new driving-box brasses, and boxes planed, new shoes and wedges, all broken or loose studs and bolts renewed. All brake and lighting equipment, injectors, lubricator, stoker, and fire door repaired, tires turned or changed, brake and spring rigging repaired, rod brasses renewed or planed and rebored, rod and valve gear bushings renewed. Valves set, crossheads and rods rebored if worn oval, guides and crossheads repaired, new engine and tender draw bars and pins, tender and engine truck wheels turned or changed, tender repaired, all other work this class of repairs should include; also any other work the past performance of the engine would indicate necessary.

With due allowance for the human element in operation and the occasional failure of parts, caused by defective material, this engine, with the work properly done, should be be able to remain in service till its next trip to the back shop, requiring a small amount of work in roundhouses, and losing a small percentage of time undergoing light repairs. During the first month the engine is in service we may expect warm journals, loose nuts, rods to key up, wedges to set up, air leaks, steam and water leaks, a spring or springs to pad or line up, brakes to adjust, adjustments to the air and lighting equipment, washouts and other light work. Later there will be main rod brasses to file or reduce; boiler checks, blow-off cocks and other valves to grind in; crossheads to line; pump, valve and piston rods to pack; brake shoes to renew; tender and engine truck brasses to change and other similar work, which is not expensive and can be handled quickly.

Then much later we may expect rod bushings to be renewed, wedges to line down, valve and cylinder packing rings to be changed, springs to be changed and possibly the valves to set. During this time there will be a certain amount of work not expected, which the best supervision and management cannot prevent. All this work constitutes approximately fifty per cent of the work that is done in roundhouses. We can accept this as a natural consequence of locomotive operation. There may be some improvement possible in handling this work; but the possibility for greater results lies in a different line.

The other fifty per cent of the work done in roundhouses includes a heavier and more expensive class of work. This work is made necessary by a comparatively small number of causes, some of which are: frames, springs and spring rigging, brake hangers and brake hanger pins breaking, tires slipping, unintelligent work reports, and the lack of coöperation between roundhouses and back shops. All of these causes or conditions exists in a sufficient number of cases or to an extent that will warrant investigation. It is not as though these things happen once in a year or other long period of time.

There are many causes for tire failures, some of which can be traced to the back shops; but the responsibility for many lies entirely with the roundhouse and enginemen. A thorough inspection of tires by enginemen and roundhouse inspectors will lessen the possibility of failures, but it will not reduce the work, and this should be our aim. Generally it is much easier to remove the cause of failures than it is to repair engines after they are broken down. This is the case with tires. There is an irregularity peculiar to engines having a two-wheel pony truck and a certain arrangement of the long equalizer, connecting the front driving springs with the pony truck. The arrangement is common in many of the different types of engines. With this type of construction the long equalizer passes over the rear of the truck frame and rests in the center of the cradle. There is a wide "V"-shaped depression in the back of the truck frame through which the equalizer passes. When all parts of the spring rigging connected to the long equalizer, and the long equalizer itself are the proper dimensions and shape, the equalizer is approximately an inch and a half above the bottom of this depression, when the engine is on straight track standing still. As the engine traverses a curve, the equalizer at the point of the depression in the truck frame will move approximately three inches to either side of center, the direction of the movement depending on the direction of the curve. It will also have an upward movement due to the angular position from a vertical line taken by the cradle hangers. There is sufficient clearance for the equalizer and all parts have a free movement and take their correct share of the weight when the engine is on a curve.

But if the equalizer is not free to take the full movement, necessitated by a curve, the very purpose for which a leading truck is placed under a locomotive is defeated. There is a rigid wheel base from the pony truck wheels to the back drivers. On some engines this depression in the truck frame is of such a shape that if the equalizer is down on the truck frame at all, it prevents any lateral movement, and the rigid wheel base is increased by approximately the distance between two more pairs of drivers. No locomotive, especially the one of today, can be wrapped around a curve.

This condition causes an enormous stress in the frames, an enormous side thrust of the tire flanges against the rail, particularly the truck wheels and back drivers; it causes excessive friction on the hubs of truck and driving wheels and boxes, robs the engine of its power by hub and flange friction, at the time it needs it most—on a curve; is the cause of spread track and broken rails, and, in general, works against every part of the engine. The preceding is written after an investigation covering four broken frames, more than twenty tire failures, and numerous cases of spread track and broken rails. The tires ranged in thickness from two and one-quarter inches to three and one half. In all the frame failures, ninety per cent of the tire failures, and practically all of the cases of spread track and broken rails this condition existed. Furthermore engines out of the back shop a comparatively short while had more lateral than engines out three times as long. All of the frames were broken on the right side just behind the cylinder saddle. A massive piece of metal, in no way defective, and weakened by one bolt hole, one and one-quarter inches in diameter. This is the natural place for a failure to occur—at the least protected part and on the right side, as the right frame between the cylinder and main driver is subjected to greater stresses than the left frame, on right lead engines. The actual cost, in the roundhouse, to remedy this condition by raising the equalizer from the truck frame was two dollars. This included mechanic's time and material. It required an hour to raise each one. The engine failures, caused by both frames and tires, averaged at least two hundred dollars each in direct cost. Besides this traffic was delayed by these failures and the service of the engine was lost for the length of time required to make repairs. The latter was a greater loss than the former.

ENGINE TRUCK, TENDER AND COACH WHEELS

Changing wheels under engine trucks, tenders and coaches is a cause of much expense. This work is necessary: there are certain definite defects which make it so. Steel wheels or steel tire wheels are changed for three principal reasons: the tread shelling out, the tread worn, and the flange worn. On not over fifty per cent of the wheels changed is the tread worn to the limit permitted. While steel wheels or tires shelling out on the tread is not uncommon, the number of wheels changed for this defect forms a small percentage of the whole. A large number of wheels are changed on account of sharp flanges. Almost invariably it will be found that there is one wheel only, with a sharp flange, and if the two wheels on the axle are calipered, it will be found that the wheel having a sharp flange is usually smaller than the other. This difference in diameter of the two wheels will be within the limits set by the Interstate Commerce Commission, but their concern is safety and not maintenance cost.

At first thought one would hardly believe a difference of three thirty-seconds in the diameters of two wheels, on the same axle, would greatly affect their action, but results seem to indicate that it does. Theoretically, we know the larger wheel will lead the smaller if there is no restriction to prevent: one wheel or both will do a certain amount of slipping; or the smaller wheel must ride higher on the tread and nearer the flange than the other. As the larger wheel has a tendency to lead the smaller it causes the flange of the smaller wheel to bear against the rail and naturally cuts the flange. This would be the case in a two-wheel truck; in a four or six-wheel truck it will affect other wheels in the truck. It may be said that this forcing of the smaller wheel flange to the rail is intermittent, as other forces counteract and overcome it at times; the force caused by the engine traversing a curve or the swaying of the engine on straight track, but these same forces augment it just as many times as they oppose it; in other words the resultant of all the forces tending to lateral movement in a pair of wheels (not drivers) for a period of time, in a round trip over the same track is nothing.

Then if there exists a difference in the diameters of two wheels on the same axle, there is a constant force in one direction.

It is possible the defect will cause an engine to sway and rock more than another engine in which this defect is not present: the smaller wheels will be forced to the flange or a point on the tread beyond that at which the two diameters are equal, then there will be a force in the opposite direction, these alternating forces continuing as long as the engine is in motion.

It has been almost conclusively proved on one road that this variation in the diameter of wheels on the same axle is the cause of ninety-five per cent of the sharp flanges, and records show that sharp flanges caused the removal of thirty per cent of all wheels changed. Almost everywhere the turning of wheels and tires in the back shop is considered rough work, and it is made even more so by the men performing it. No doubt this carelessness in turning wheels and tires has grown in the past few years, and it seems that the ill effects resulting from it have passed unnoticed. Among railroad mechanics it is a well known fact that the degree of precision in railroad shops today is not what it was a few yeare ago. Generally this is as it should be, but there are some operations which deserve closer limits than the present practice; the turning of tires and wheels is one of them. This is one evil in locomotive and car maintenance which can be corrected with no expenditure and no change of system in any way.

It will pay any official to caliper and examine a number of wheels having sharp flanges; also to caliper and examine a number of wheels which have been turned.

The greater number will be surprised by the results of their investigation. If this is pursued farther, the wheels marked or the record of wheels watched closely, it will be found that the wheels which varied in size (on the same axle) will be changed within six months, for a sharp flange on the smaller wheel. It is not uncommon for wheels to be removed for this cause four months from the date they were put in. It is a very easy matter to test the authenticity of the foregoing. A fifteen-minute investigation of both old and new wheels is all that is necessary.

Locomotive Exports.

From the reports already published in the first eight months of this year the United States exported 1,150 locomotives to all parts of the world, nearly 200 more than in all of last year and more than twice as many as normally exported annually before the war. Details are given by the National Bank of Commerce in New York in the November number of its magazine, *Commerce Monthly*. The largest locomotive purchases this year have been made by Belgium, Italy, France, Poland and Danzig.

"Before the war," says *Commerce Monthly*, "export of locomotives was concentrated in the hands of the great steel producing countries—Great Britain, Germany and the United States. American sales to Europe were very small. During the war, however, the United States was called upon to supply locomotives to Europe, and, in 1918, even sent 241 to England. Since the close of the war the United States has been the only country prepared to ship locomotives in quantity."

Railroads' Coal Bill.

The total coal bill of the largest railroads for the first six months of this year was $296,836,000, compared with $159,-285,000 during the same time last year, or a difference of $46,550,000. The railroads during the first six months of this year burned 55,325,387 tons of coal and 47,585,257 tons in the corresponding period last year. The figures do not include coal burned by locomotives in yard and terminal service.

The average increased cost of coal per ton to the railroads this year is 39 cents above the costs last year. This advance is approximately the sum of the wage increase which was granted to the miners under the award of the Bituminous Coal Commission. The increased cost has gradually advanced during each month this year, it is pointed out. In June the railroads paid an average of 80 cents a ton more for coal than was paid in the same month last year.

Government Payment to the Railroads

It is reported that approximately $233,-000,000 has been paid by the Government to the railroads under the guarantee clause of the Esch-Cummins transportation law. Payments must continue until the roads receive approximately $600,-000,000, it is now estimated. The guarantee clause under which the money is paid provides that the Government must pay the roads a sum sufficient to insure a standard return for the first six months of private operation, which ended September 1. The standard return is an average of the returns of the roads for three pre-war years. The roads have been checking up their income for September, after which they will file claims with the Interstate Commerce Commission.

The Central Argentine Railway.

The Central Argentine Railway is an amlagamtion of a large number of separate lines that have been acquired from time to time. The Buenos Aires a Resario Railway united in 1902, with the old Central Argentine Railway, and the amalgation was sanotioned by the Argentine Congress in 1908, when the name of the latter company was assumed. On the joint system the length of line in operation on the 5 ft. 6 in. gauge is 3,305 miles, being second only to the Buenos Aires Great Southern, which has 3,792 miles. The main line runs from the city of Buenos Aires, via Rosario, to Tucuman, where it connects with the Government metre-gauge system extending further north. A second line connects Buenos Aires with Rosario by a longer route.

Electrification of Chilean Railways

The Chilean Government has called for bids for the electrification of the first zone of the State railways. This zone comprises the line which runs from Valparaiso to Santiago. The bids, which will be received up to March 31, 1921, are of two classes: those proposing to furnish the electric power, and those proposing to furnish the actual equipment and rolling stock of the line to be electrified. The Latin American Division has booklets containing the conditions on which the bids must be based, and the address of the department from which plans and specifications may be obtained.

The Niagara Bridge.

As a result of a thorough overhauling the steel arch carrying the Grand Trunk Railway over the Niagara Gorge has been strengthened to carry loads 62 per cent. greater than those for which it was designed 22 years ago. To effect this, addition has only been made of 600 tons of new metal, none of which was employed on the main members of the arch. The bridge was built in 1897 as the third structure to span the Niagara River at the same site. A light suspension span for pedestrian traffic was built in 1848, and was replaced in 1855 by the famous suspension bridge of John A. Roebling, which did useful service for 43 years. The present structure carries two railway tracks on an upper deck, and a highway on a lower deck with sidewalks cantilevered on either side. The railway deck accommodates some 70 or 80 trains a day of the Grand Trunk and connecting American lines.

New Motive Power.

According to reports to the Interstate Commerce Commission unofficially summarized on August 30, the railroads plan the purchase of 1,800 locomotives this year at a cost of more than $105,000,000. In the programme for the utilization of the $300,000,000 revolving loan fund provided for in the Transportation Act, there are loans to some 32 companies amounting to $29,000,000 to enable them to acquire 636 freight locomotives and 277 switching locomotives, having a total value of approximately $58,000,000.

Reid Newfoundland Railway

The commission appointed by the Newfoundland Government under an act passed at the Legislature's last session has started work. Among the recommendations, according to a press report, affecting the operation of the railway already made, is one for an increase in passenger fares and freight rates, the percentage of which had not been fixed September 16. The granting of passes, which it is stated had assumed "enormous proportions," is reported to have been abolished. To this regulation, it is said, there are to be no exceptions whatever, the privileges heretofore granted to members of Parliament and to most of the company's officials being abolished.

Car Loading Increase

As indicating the progress made by the railroads in speeding up the movement of freight reports show that the mileage made by the average freight car per day during the month of July, was 26.1, an increase of two miles per car per day over 1919. For June the average was 25. An increase is shown each month except in April, when the switchmen's strike reduced the movement of cars. An improvement of one mile in the average is equivalent to an addition of about 100,000 cars to the freight equipment of the country.

James Watt Memorial

The James Watt Executive Committee, of Birmingham, England appointed at a centenary commemoration of James Watt, held in England last fall, has collected a part of the £150,000 sterling which it is trying to raise for the purpose of establishing a memorial to perpetuate the name of James Watt. It is the intention to endow a professorship of engineering to be known as the James Watt chair, at the University of Birmingham, for the promotion of research in the principles underlying the production of power.

Mikado Type Locomotive for the Chicago, Milwaukee and St. Paul Railway

Equipped With Many Modern Improvements

One of the most notable locomotive orders now being filled is that calling for 100 locomotives of the Mikado (2-8-2) type for the Chicago, Milwaukee & St. Paul Ry. These locomotives are being built by The Baldwin Locomotive Works, and the general design is in accordance with drawings and specifications prepared by the railway company. Certain modifications have, however, been introduced in accordance with the practice of the builders. The new engines are designated by the railway as class L 2-a, and while not exceptionally heavy machines of their type, are excellent representatives of a class of power that is proving highly efficient in freight service the country over.

These locomotives, in weight and capacity, are closely similar to the light Mikados built for the United States Railroad Administration. They carry approximately 54,000 pounds on each pair of driving wheels, and exert a tractive force of 54,720 pounds. The ratio of adhesion is therefore very nearly 4, indicating that the weight on drivers is utilized to excellent advantage.

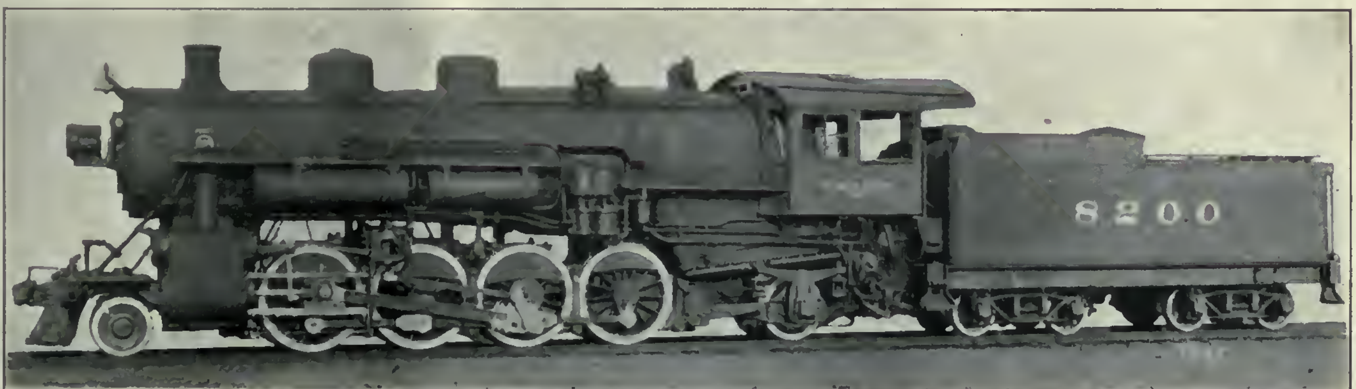
The boiler presents a number of interesting features, its design and proportions being suitable for the operating conditions on the Milwaukee road. The barrel is built with a conical wagon-top, increasing the shell diameter from 78¾" at the first ring to 87½" at the throat. This arrangement permits a 7½" water space around the sides and bottom of the combustion chamber; while the depth of the firebox throat, from the under side of the barrel to the bottom of the mud ring, is 29". The combusion chamber is 36 inches long, and the tube length 17' 6". For a locomotive of this capacity, the grate area (49 sq. ft.) is comparatively moderate; and the side water legs of the firebox are inclined inwards toward the bottom. The firebox sides and crown, together with the combustion chamber are made in one piece; and the combustion chamber has a welded seam on the bottom center. Flexible staybolts are used in the breaking zones in the sides, back and throat of the firebox, and in the sides of the combustion chamber; and the forward end of the crownsheet is supported by three rows of flexible stays.

The firebox is equipped with a smoke consumer, having two combustion tubes in each side and two in the back. It also contains a brick arch, which is supported o four 3-inch water tubes. The locomotive is fired with a Duplex stoker, and a power operated grate shaker is applied. The ash pan is arranged with two hoppers. The bottom of each hopper is semi-circular in cross section, and is on a sufficient slope to enable the ashes to slide out when the hopper doors are opened.

The cylinder castings are most substantial in design, with walls of ample thickness to withstand severe stresses. The castings are bolted to the smoke box by a double row of bolts all around, and the flange on the casting is 3 inches thick where the bolts pass through. The cylinders are not bushed but the barrel walls are 2⅛ inches thick, so that they can be subsequently bored out and brushed if desired.

The steam distribution is controlled by 14-inch piston valves, which are driven by Baker gear and set with a lead of ¼". The valve bull rings and valve packing rings are of Hunt-Spiller iron, as are also the cross-head shoes, piston heads and piston packing rings. The piston heads are of box form, designed in accordance with the railway company's standard practice. The piston rods are of heat-treated carbon steel, and the crank pins and main driving axle are also heat treated. A Ragonnet type "B" power reverse gear is applied.

The main frames are six inches in width, and each is cast in one piece. The frames are braced transversely, between the first and second pairs of driving wheels, by the guide yoke; and between the second and third pairs by a broad steel casting which supports two boiler waist sheets and also the reverse shaft. This shaft is provided with an intermediate bearing, so that it is rigidly held in alinement. Above the rear driving pedestals is another cast steel brace, which has a long bearing on the frames, and also supports a boiler waist sheet. The lower frame rails are braced back of the second driving pedestals and just forward of the rear driving pedestals. A Commonwealth rear frame is applied, and is designed for use with the Hodges type of trailing truck. This truck, in the present instance, equalizes with the third and fourth pairs of driving wheels, while the first and second pairs of drivers are equalized with the leading truck. The driving tires are all flanged, and those of the front and rear pairs of wheels have ¼" more total play between rails and flanges than those of the two middle pairs. The driving wheel centers have cast iron hub liners.



MIKADO 2-8-2 TYPE LOCOMOTIVE FOR THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.
Baldwin Locomotive Works, Builders.

The cab is of steel, wood lined throughout, and is arranged to provide ample deck space. Attention may be called to the location of some of the cab fittings. The throttle lever has an outside connection with the throttle valve, and is placed in a vertical position on the right hand side. This leaves the center of the back head clear above the fire-door. The gauge glass is placed with its lowest reading 4½" above the highest point of the crown sheet; and its lower connection to the boiler is made between the arch tubes, where the water is subject to a minimum amount of disturbance. The lowest gauge is 5½" above the highest point of the crown sheet. Special attention has been given to the comfort and convenience of the engine crew in locating the cab fittings, steps and hand holds.

The equipment of the locomotive includes two blow-off cocks, one in each side water leg and both operated from the cab. A five-feed lubricator is used, and is tapped to each steam chest, the air pump and the stoker engine; one feed being plugged.

The tender frame is built up, with 13-inch steel channels for the longitudinal sills and bumpers of wood and steel plate. The trucks are of the arch-bar type, and are carried on "Standard" rolled steel wheels. Similar wheels are used in the front engine truck.

The materials of which these locomotives are built, generally conform to the specifications issued by the American Society for Testing Materials. Further particulars are given in the table of dimensions.

Gauge, 4 ft. 8½ ins.; cylinders, 26 ins. x 30 ins.; valves, piston, 14 ins. diam.

Boiler—Type, Conical wagon top; diameter, 75¾ ins.; thickness of barrel sheets, ¾ in. and ⅞ in.; working pressure, 200 lbs.; fuel, soft coal.

Firebox—Material, steel; staying, radial; length, 107¾ ins.; width, 65¾ ins.; depth, front 91⅛ ins.; depth, back 74⅛ ins.; thickness of sheets, sides, ⅜ in.; thickness of sheets, back, ⅜ in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, ⅝ inches.

Water Space—Front, 4½ ins.; sides, 4 ins.; back, 4 ins.

Tubes—Diameter, 5⅜ ins.; material steel; thickness, No. 9 W. G.; number, 30; length, 17 ft. 6 ins.

Tubes—Diameter, 2 ins.; material, steel; thickness, No. 11 W. G.; number, 226; length, 17 ft. 6 ins.

Heating Surface—Firebox, 213 sq. ft.; combustion chamber, 64 sq. ft.; tubes, 2,796 sq. ft.; firebrick tubes, 26 sq. ft.; total, 3,099 sq. ft.; superheater, 640 sq. ft.; grate area, 49 sq. ft.

Driving Wheels—Diameter, outside 63 ins.; diameter center, 56 in.; journals, main, 11 ins. x 12 ins.; journals, others, 9½ ins. x 12 ins.

Engine Truck Wheels—Diameter, front, 33 ins.; journals, 6½ ins. x 12 ins.; diameter, back 43 ins.; journals, 9 ins. x 14 ins.

Wheel Base—Driving, 16 ft. 6 ins.; rigid, 16 ft. 6 ins.; total engine, 35 ft. 3 ins.; total engine and tender, 66 ft. 8¼ ins.

Weight—On driving wheels, 216,350 lbs.; on truck, front, 24,650 lbs.; on truck, back, 46,600 lbs.; total engine 287,600 lbs.; total engine and tender, 452,600 lbs.

Tender—Wheels, number, 8; wheels, diameter, 33 ins.; journals, 5½ ins. x 10 ins.; tank capacity 8,500 U. S. gals.; fuel capacity, 12 tons; tractive force, 54,720 lbs.; service, freight.

Engine House Organization

E. R. Webb, master mechanic of the Michigan Central Railroad, St. Thomas, Ont., presented a paper before the members of the Central Railway Club, at Buffalo, N. Y., at the November meeting. As a model of condensation it is worthy of imitation. We have often heard it remarked that the best mechanics rarely speak of their work, and if they do speak at all, their remarks have the merit of sententiousness. We know Mr. Webb to be a mechanic of the first rank; and we take pleasure in reproducing his paper in full.

"To have a proper engine house organization it would be necessary to first have proper supervision. This means to have enough of the right class of men to handle the work according to the size of the engine house and the number of engines despatched per day. The next in connection with the organization is the system of handling the work.

"When the engine arrives at the coal dock after making its trip, and has a full pressure of air, the air brake inspector should be assigned to inspect all the air, steam heat and scoop operating equipment and report any defects which he may notice. This inspection should take place while the engineer is inspecting the engine, and be reported to the engine house office as soon as the inspection is finished, so that the work report will be made out at the same time that the work is reported by the engineer.

"The engine is then handled by the hostlers, coaled, sanded, fire dumped, watered, washed off and placed in the engine house. As soon as the engine arrives in the engine house, boiler, machinery and tank inspectors should thoroughly inspect it and the work reported to the engine house office as quickly as possible, so that it may be included with reports by the engineer and air inspector. This work should be copied off on forms and distributed to the different departments. When it is finished the heads of these departments should have the men who have done the work sign the slips so that in case of inferior work or other trouble, the work can be traced to those responsible. The foreman should then take the slips into the engine house office, where the work is checked off the work book and the slip filed. As soon as the foreman of each department completes the work on a locomotive he should O. K. the engine on a board, which should be in every engine house, and made so that there is a place for each foreman of a department to O. K. his work. When the engine is reported O. K. on the board, final inspectors should then go over the engine and see that the work has been done properly and that nothing has been missed. The board or reports to the engine house foreman should then be O. K'd. The engine is then ready for service.

"In case an engine comes in that is due for quarterly or monthly inspection, or hydrostatic test, orifice test or washout, a man designated to look after the reports should have a stenciled sign placed on the front of the engine showing any or all inspections due.

"Proper drop pits, machine shops, and tool rooms are a very essential part of the engine house equipment, and should be kept up to a high standard so that the very quickest turns that are always occurring in engine houses will not be delayed on account of having inferior machines, tools or drop pits.

"It is also very important that the road foreman of engines should keep in close touch with the engine house organization and report needed work, so that the report of needed work is in the engine house office when the engine arrives at a terminal.

"Many other essential features in connection with the engine house equipment add to its efficiency, such as heat, light and ventilation, proper facilities for handling material, wash rooms and lunch rooms. Every effort should be made by the men in connection with the engine house organization to maintain the force in a harmonious and willing spirit, as it is essential that all in such an organization pull together."

Domestic Exports from the United States by Countries During September, 1920.

STEAM LOCOMOTIVES

Countries.	Number.	Dollars.
France	36	1,080,000
Italy	28	182,000
Roumania	10	650,000
Spain	15	621,000
Canada	6	96,711
Mexico	8	45,405
Newfoundland & Labrador	1	20,445
Cuba	21	491,604
Dominican Republic	2	26,500
Colombia	2	45,020
China	21	816,070
Philippine Islands	2	15,900
British South Africa	2	14,750
Totals	154	4,105,405

The Condition of the Railways in Poland

By Captain W. M. Gwynn, A. E. F.

"There are worse railroads in Europe than those in Poland," according to W. M. Gwynn, who has just returned from over a year's stay in that country, "but that is not saying much.

"In spite of the tremendous efforts that the Poles have made to rehabilitate their transportation systems following the wreckage of the war," continued Mr. Gwynn, "there is still much to be desired. The trains are entirely inadequate to accommodate the crowds who wish to take them. There are some trains with sleepers on them, but you are more than lucky if you get them. The American boys who travelled in the French box cars, '40 hommes and 8 chevaux,' can form some idea of the crowded condition if they can imagine about 60 men and women, with all their bags and baskets packed into the same space. All of them are dirty, ragged, and many are infested with vermin. The crowds are so great that many are forced to ride on the car roofs and on the bumpers. Some actually cling all night long to the platform steps. On the train in which I journeyed from Lemberg to Cracow, there were a number of soldiers riding on top of the cars. Two of them were killed by striking their heads on low bridges. The jam in the New York subways is not to be compared to it."

Mr. Gwynn, who held a commission as captain in the American Expeditionary Forces, has been in Europe since the spring of 1916. Since August of last year he has been in charge of the American Relief Administration's warehouse at Lemberg, but was forced to withdraw from that city when the Bolsheviki had almost encircled it.

The conditions in Poland he describes as even more serious at present than they were last winter when the American Relief Administration was called upon to feed in that country alone 1,300,000 starving and destitute children.

"The invasion of the Bolsheviki, with the destruction of crops incident thereto, unfavorable weather conditions, resulting in decreased yields on the acreage not stripped by the invaders, are two of the chief factors which will make it necessary to continue American aid on an undiminished scale," said Captain Gwynn.

The American Relief Administration, of which Herbert Hoover is chairman, has since this invasion again stocked and opened its Lemberg warehouse, and hopes to continue the feeding of the children from its hundreds of kitchens throughout Poland until the next harvest. At present, however, there are funds available only sufficient to carry on the child feeding until January 1.

The Application of Power Brakes to European Freight Trains.

The question is now before the public in Europe of the application of a system of power brakes to freight trains, so that cars of standard gauge may be freely interchanged between the principal countries, and move over the main lines of railway without breaking up the trains.

The matter was discussed in a recent issue of the *Schweizer* (Swiss) *Banzeitung* calling attention to the importance of the matter to the Swiss railways. The writer calls Switzerland the turntable of Europe in that it receives cars from all of the surrounding countries.

Here the matter of brakes is one of prime importance because of the undulating condition of the grades. All of the Swiss locomotives and passenger cars and a portion of the freight cars are fitted with compressed air brakes, but some engineers in the other countries are advocating the use of the vacuum brake, especially for freight trains.

Without presuming to settle the dispute the author calls attention to the possibility of the electrification of the Swiss Federal railways when it may be advisable to use regenerative braking. But it would be hazardous to predict when such an electrification will be completed, and, meanwhile, it is certainly a matter of prime importance to the interchange of traffic on international railways that there should be a uniform system of brakes in use, so that trains may be run from France to Roumania or Greece.

War Memorials for the Canadian Pacific.

Two imposing statuary groups have been designed for Canadian Pacific railway stations at Montreal and Winnipeg, to stand as a tribute to the heroism and self-sacrifice of the 1,096 employes of the road who died in the great war, and bronze memorial tablets are to be placed at a large number of the principal offices and stations to perpetuate the memory of the 11,692 employes who were engaged in the war. Replicas of the tablets will also be placed in London, Liverpool and the Orient.

The statuary groups have the fine quality of not requiring any particular description. A winged figure bearing a dead soldier has much of the spirit of Flaxman's illustrations of Homer's Iliad, but it is not in any sense an imitation but is marked by originality in conception and skill in execution.

Domestic Exports from the United States by Countries, During August, 1920. Steam Locomotives.

Countries	Number	Dollars
Belgium	32	1,857,988
Poland and Danzig	3	139,500
Roumania	15	975,000
Spain	15	656,580
Canada	1	15,368
Honduras	1	3,700
Mexico	6	70,500
Jamaica	1	21,800
Cuba	32	1,123,722
Brazil	5	98,290
Chile	1	8,400
Colombia	2	63,940
Philippine Islands	1	21,800
French Afrcia	10	368,000
Total	125	5,424,588

The Coal Fields of Lorraine.

The wrecking of the mines of northern France by the Germans has been one of the factors in producing the present acuteness in the coal situation of the world. It was in partial compensation for this wrecking that the control of the Sarre basin was given to France. The annual production of this basin was about 17,000,000 tons, and of this, after making all allowances for local consumption, about 8,000,000 tons would be available to meet outside demands. This output of 17,000,000 would be easily developed given the necessary time to establish new operations and provide for the amortization of the initial costs. It is true that the coal is of a mediocre quality and is incapable of producing a metallurgical coke. This is not, however, a serious handicap, as down to a depth of 3,250 feet it represents a reserve of about 8,000,000,000 tons.

Keeping Up the Good Work.

For the week ending October 9, the American railroads handled 1,009,787 cars as compared with 982,171 in the corresponding week of 1919 and 959,722 in the corresponding week of 1918. This is the first time that car loading has exceeded the million-car mark this year.

New York Central Locomotive No. 999

The much heralded engine which was said to have drawn the Empire State Express of the New York Central a short distance at the rate of 112.5 miles an hour, after undergoing reconstructions, alterations and repairs during twenty-seven years of variable service is being dismantled. The alleged record had no foundation in fact. The boiler sheets were among the first thick enough to resist increased steam pressure, and in light service its records were about the average, but in running from one division point to another it never equalled present day practice.

The best that can honestly be said of it is that it was a step in the right direction.

Items of Personal Interest

A. K. Rowe has been made road foreman of engines of the Chicago Great Western with office at St. Paul, Minn.

C. L. Bunch has been appointed master mechanic of the Southern at Meridian, Miss., succeeding H. M. Little, resigned.

J. Matthes has been appointed chief car inspector of the Wabash, with headquarters at Decatur, Ill., succeeding J. C. Keene.

R. C. Bardwell, chemist for the Missouri Pacific at St. Louis, Mo., has been appointed engineer, water service, with headquarters at St. Louis.

Samuel P. Coffin, supervisor of bridges and buildings of the Boston & Maine, with headquarters at Boston, Mass., has been transferred to Salem, Mass.

J. B. Doles has been appointed chief despatcher on the Oregon Short Line, with headquarters at Nampa, Idaho, succeeding C. Fowler, resigned.

Thomas M. Allison has been appointed road foreman of engines on the Northern Pacific, with headquarters at Fraser, Wash., succeeding P. A. Wirth.

C. E. Oakes has been appointed shop superintendent of the Kansas City Southern, with headquarters at Pittsburg, Kan., succeeding William Turley, resigned.

H. B. Wills has been appointed chief despatcher of the Philadelphia & Reading, with headquarters at Philadelphia, Pa., succeeding B. H. Baker, promoted.

J. Gutteridge, foreman of the car department of the Kansas City Southern, Kan., has been appointed general foreman of the car department, with headquarters at Pittsburg, Kan.

Andrew McCowan, master car builder of the Canadian National, with headquarters at Winnipeg, Man., has had his jurisdiction extended to the lines of the Grand Trunk Pacific.

J. J. Connors, general superintendent of the Morrison Foundry Company, has been appointed superintendent of motive power of the Denver & Salt Lake, with headquarters at Denver, Colo.

C. J. Quantie, master mechanic of the Canadian National at Fort Mann, B. C., has been transferred to Vancouver, with jurisdiction over all lines west of and not including Edmonton, Alta.

S. J. Lipton, chief boiler inspector of the Canadian National railways, with headquarters at Winnipeg, Man., has had his jurisdiction extended to include the line of the Grand Trunk Pacific.

H. Brinkman has been appointed master mechanic of the Southern division of the Chicago Great Western, with headquarters at Des Moines, Iowa, succeeding A. B. Clark, promoted.

Col. James A. McCrea, formerly manager of the Long Island railroad, has been elected vice-president of the Pennsylvania. Col. McCrea was deputy director of transportation in France during the war.

John Herron has been appointed acting superintendent of motive power and machinery of the Duluth, South Shore & Atlantic, with office at Marquette, Mich., vice I. J. Connolly granted leave of absence.

F. R. Bolles, vice-president and general manager of the American Automatic Connector Company, Cleveland, Ohio, has been placed in charge of the offices and exhibit room at 235 Railway Exchange building, Chicago, Ill.

W. H. Sanford, district manager of the Buffalo, N. Y., plants of the American Car & Foundry Company, New York, has been appointed assistant vice-president in charge of sales in the Buffalo division.

Andrew H. Cairns, district manager of the American Car & Foundry Company at Chicago, Ill., has been appointed district manager of the Buffalo plants and the plant at Depew, N. Y., succeeding W. H. Sanford.

G. E. Smart, general master car builder of the Grand Trunk Pacific, with headquarters at Toronto, Ont., has been appointed mechanical assistant in the car department in that city, assisting S. J. Hungerford in mechanical matters.

A. L. Whipple, vice-president and acting manager of the Railway Improvement Company of New York has been appointed to the position of representative of the Locomotive Stoker Company, with headquarters at 50 Church St., New York.

A. B. Clark, master mechanic of the Southern division of the Chicago Great Western, with headquarters at Des Moines, Iowa, has been promoted to superintendent of shops, with headquarters at Oelwein, Iowa, succeeding M. H. Oakes.

R. C. Hempstead, division master mechanic of the Chicago, Milwaukee & St. Paul, with headquarters at Madison, Wis., has been transferred to the Kansas City division, with headquarters at Ottumwa, Iowa, and W. C. Kenney succeeds Mr. Hempstead.

Ivy L. Lee, long and favorably known in connection with the department of publicity in the Pennsylvania Company, in the pre-war days, has been retained by the Board of Directors to act in an advising capacity in matters of publicity and public relations.

William M. Morris, assistant general purchasing agent of the Pennsylvania, with headquarters at Philadelphia, Pa., has been appointed purchasing agent of the Northwestern region of the Pennsylvania, with headquarters at Chicago, Ill., succeeding I. B. Thomas.

C. E. Brooks, superintendent of motive power of the Grand Trunk Pacific, with headquarters at Winnipeg, Man., has been appointed mechanical assistant of the locomotive department of the Canadian National and the Grand Trunk Pacific, with quarters at Toronto, Ont.

S. J. Kelley has been appointed master mechanic of the Allegheny and Bradford divisions of the Erie, with headquarters at Hornell, N. Y. This appointment is the result of the creation of a new division, the Susquehanna and Tioga divisions forming a separate division of which C. H. Norton remains master mechanic.

E. V. Reinhold, assistant to the manager of purchases and stores of the New York Central Lines, with headquarters at Buffalo, N. Y., has been appointed assistant purchasing agent in charge of fuel, of the New York Central Railroad, with headquarters at New York.

A. Walts, district master mechanic of the Grand Trunk Pacific, with headquarters at Smithers, B. C., has been appointed assistant master mechanic of the Canadian National and the Grand Trunk Pacific, with jurisdiction on all lines from McBride, B. C., to Prince Rupert.

Henry Holgate, consulting engineer, Montreal, Canada, has been retained by the Department of Railways and Canals to report on the power shortage in the Trent Valley, Ontario, and to determine the possibility of the development of power by the Hydro-Electric Power Commission of Ontario.

A. H. Mahan, district master mechanic of the Grand Trunk Pacific at Edson, Alta., has been appointed assistant master mechanic of the Canadian National and the Grand Trunk Pacific with jurisdiction over the lines from Edmonton, Alta., to McBride, B. C., and from Edson to Mountain Park, Alta., with headquarters at Edson.

Charles James, mechanical superintendent of the Hornell region of the Erie, with headquarters at Hornell, N. Y., has been transferred to the Ohio region with headquarters at Youngstown, Ohio; and F. H. Murray, shop superintendent at Susquehanna, Pa., has been appointed to succeed Mr. James; J. Todd, general foreman at Susquehanna, succeeding Mr. Murray.

U. K. Hall, general storekeeper of the Union Pacific, with headquarters at Omaha, Neb., has been appointed general supervisor of stores of the Union Pacific System. The office of general supervisor is a newly-created position, and marks the beginning of new plans and policies in connection with the stores organization of the Union Pacific system.

Charles E. Patterson, comptroller of the General Electric Company, has been elected vcie-president of the company. Mr. Patterson has had a wide experience on several of the leading railroads, and aided in the development of the Interstate Commerce Commission's accounting system for railways, and was chairman of the committee of the Electric Manufacturers' Council.

OBITUARY

Richard Lamb

The death is announced of Richard Lamb, formerly chief engineer of the Wilmington & Neburn, now a part of the Atlantic Coast Line. Mr. Lamb won an enviable reputation as a constructing engineer. He had charge of the building of the largest coal dock in the world and planned the drainage of the Dismal Swamp. The development of the refining of copper ore by electricity is also credited to his inventive ability. Mr. Lamb had retired from active work for some time. His death occurred in Brooklyn, N. Y., on October 18.

James Clarence Harbourt

James C. Harbourt, chief of publicity of the Westinghouse Air Brake Company, Pittsburgh, Pa., died at his home in Pittsburgh, on October 9. Mr. Harbourt was an engaging and accomplished writer, and an earnest and active manager in his special sphere of intellectual activity.

George Tangye

George Tangye, the last survivor of four brothers, all eminent British engineers, died on October 7, in his eighty-fifth year. The firm established by the brothers has assumed a commanding position in Birmingham. It was more, however, by the development in the manufacture of steam engines and other machinery than by any particular inventions of their own that the firm owed its marked success. The claim that one of the brothers, James Tangye, invented the hydraulic jack in 1856 has been repeatedly disclaimed. The hydraulic jack was invented and patented in America by Richard Dudgeon in 1851, and Mr. Dudgeon introduced his invention in Great Britain, on which Mr. Tangye made some unimportant changes. Mr. George Tangye took a prominent part in the establishment and development of the company, and was for many years chairman of the company. His benefactions to Birmingham were numerous and valuable, among others a vast collection of memorials of James Watt, the creator of steam engineering.

George W. Stevens.

George W. Stevens, president of the Chesapeake & Ohio railroad, died suddenly on November 3, at White Sulphur Springs, W. Va. Mr. Stevens was in the sixty-ninth year of his age. He entered railway service at the age of thirteen as office messenger on the Baltimore & Ohio, and was engaged on various railroads, rising rapidly in the transportation department. On entering the service of the Chesapeake & Ohio, he served successively as general superintendent, general manager and president, to which latter position he was elected in 1900.

Books, Bulletins, Etc.

The Locomotive Up to Date. By Chas. McShane. Published by Griffin & Winters, Chicago, Ill. 891 pages, fully illustrated, cloth extra.

This work, which met with marked popular favor in an earlier edition, and which has been for some time out of print, appears in a newly revised and enlarged edition. It need hardly be said that a revision was necessary, as the vast changes and improvements on the locomotive during the present century, renders all books written previous to that period as belonging more to the historical category of publications than in meeting the requirements of present-day practice. The same will no doubt be said twenty years hence in regard to works of the present day. Even the distribution of steam, generally known as the valve gear, has changed, or been translated, during our own day. This feature of Mr. Mcshane's work shows how painstaking he has been in his revision work. Valves and valve gears occupies no less than 346 pages of the work, and in point of mastery of detail could not be surpassed. Whether the same could be said of the large number of other subjects treated in the work is doubtful, because in these days when common paper is nearly equal to gold leaf in price, it would be impossible to treat every subject with the same degree of fulness unless the work rivaled the *Encyclopedia Brittanica* in size, and for which the ordinary mechanical railroad man could hardly be expected to pay even with his increased remuneration. As it is, every subject is treated clearly and with absolute reliability, showing how carefully the accomplished author has mastered every subject. It would be invidious to attempt to characterize even briefly the multiplex details of the work where all subjects are excellently treated. We commend the book to our readers with all the unction that we possess. It is a library in itself. It is a monumental work. The paper and presswork are good, the illustrations are readily understood and helpful to the reader. The binding is durable. The price is less than a day's wages of an hostler.

Baldwin Record No. 98.

Locomotives for Heavy Passenger Service are finely illustrated in The Baldwin Locomotive Works Record No. 98. About thirty locomotives are shown mostly of the Pacific type, two types of the six coupled locomotives are used in passenger service, the Ten-wheeled (4-6-0) and the Pacific (4-6-2). The latter is preferred for heavy work, space being available for a firebox of any dimensions required. This type of locomotive has largely replaced the Atlantic (4-4-2) type locomotives in handling many of the fastest and heaviest passenger trains. Some of the Mountain (4-8-2) type are also shown in the Record. This type is particularly fitted for heavy passenger service where wheel-loads are limited by track conditions, and locomotives of high power are required. This type in service on the Atchison, Topeka and Santa Fe have a weight of 243,100 pounds on the driving wheels, with 58,100 pounds on the front truck, and 66,500 pounds on the back truck, making a total weight of engine of 367,700 pounds, engine and tender amounting to 610,100 rounds. The illustrations in the Record are particularly fine, and the presswork and paper of the best.

Statistics of Railways in the United States.

The thirty-second annual report of the statistics of railways in the United States for the year ending December 31, 1918, has been issued for the Government Printing Office, under the supervision of the Director of Statistics. For that year the compilation of the statistics was complicated by the fact that a large proportion of the roads were operated by the United States Government. No attempt has been made in the report to give a combined report of the Federal and corporate income accounts of each road. As formerly, the roads are divided into three classes, Class I, including those having annual operating revenues above $1,000,000, Class II, over $100,000; in Class III, below that of Class II, few details are shown because the reports are incomplete.

The data is, generally speaking, almost complete in financial detail, the matter extending to nearly 100 pages. The general physical and mechanical details show that a slight decrease occurred during the year, but so slight that it might be said that the roads had remained practically stationary. In the matter of mileage Class I shows a total of 179,963.67 miles in operation; Class II, 15,692.01 miles; Class III, 7,097.27 miles. Non-operating companies, 44,001.45 miles; companies not filing reports, 6,774.47 miles, making a total mileage of 253,528.87. In the matter of the length of mileage by States, Texas heads the list with 16,284.70 miles; Illinois second with 13,244.44 miles, and Pennsylvania third with 12,219.18 miles.

The number of operating roads under Federal operation at some time during 1918 is shown in the following table:

Class of operating road	Number of roads reporting as: Under private operation	Under Federal operation	Total
Class I............	16	173	189
II...........	166	118	284
III..........	332	55	387
Switching and terminal companies..	96	136	232
Total	610	482	1,092

Of the roads operating 74 were in the hands of receivers, with a total mileage of 16,805 miles, the largest in point of mileage being the Denver & Rio Grande, 2,558.46 miles; Texas & Pacific, 1,857.68 miles, and Missouri, Kansas & Texas, 1,662.50 miles.

The number of steam locomotives was 67,563, with an average tractive power of 33,301 lbs. Locomotives other than steam numbered 373. Freight cars numbered 2,427,460; passenger cars, 56,611; company service cars, 105,192. The number of employes, including officers, 1,837,663.

Railroad Motor Cars.

Vital Features Affecting the Safety and Efficient Operation of Railroad Motor Cars, is the title of a booklet just published by the Advertising Department of The Buda Company at Harvey, Illinois. It dwells on the uses and abuses of Railroad Motor Cars, giving real hints and suggestions for insuring better methods by which more economical operation may be obtained. It is an attractive booklet written well and full of vital suggestions, outlining common faults in the use of Railroad Motor Cars, which many times result in bad accidents and damage to property. It does not stop with merely calling attention to these faults but it outlines methods by which they may be avoided. It is now ready for distribution and is to be mailed to all railroad officials interested in the proper use of Railroad Motor Cars.

Preserving Wood Poles.

The Engineering Department of Purdue University has issued Circular No. 2 in the "Preservative Treatment of Wood Poles." It is an ably written treatise by R. W. Achatz, and is intended for the use of those who are responsible for the planning and supervision of pole line construction. The methods and economies of pole treatment are shown together with the results found by inspections in various places. Free use has been made of the available literature on the subject of wood preservation, and the circular is a valuable contribution that will be appreciated by manufacturers and pole companies, and to all interested on the subject of pole treatment under actual field conditions.

Railroad Greases.

The Texas Company, in the latest issue of *Lubrication*, has, among other interesting matter, a valuable article on railroad greases. The knowledge and skill of the grease maker is drawn to the reader's attention, the choosing of the proper stocks and combinations of fats, bases and mineral oils to make the desired grease. There is real skill required to make batches of the proper color, consisting of brightness and hardness. This faculty does not come in a day. It is best to take the judgment of the lubricating engineer in the selection of grease, and the wider his experience the more likely it is that the advice will be of value.

Railway and Locomotive Engineering

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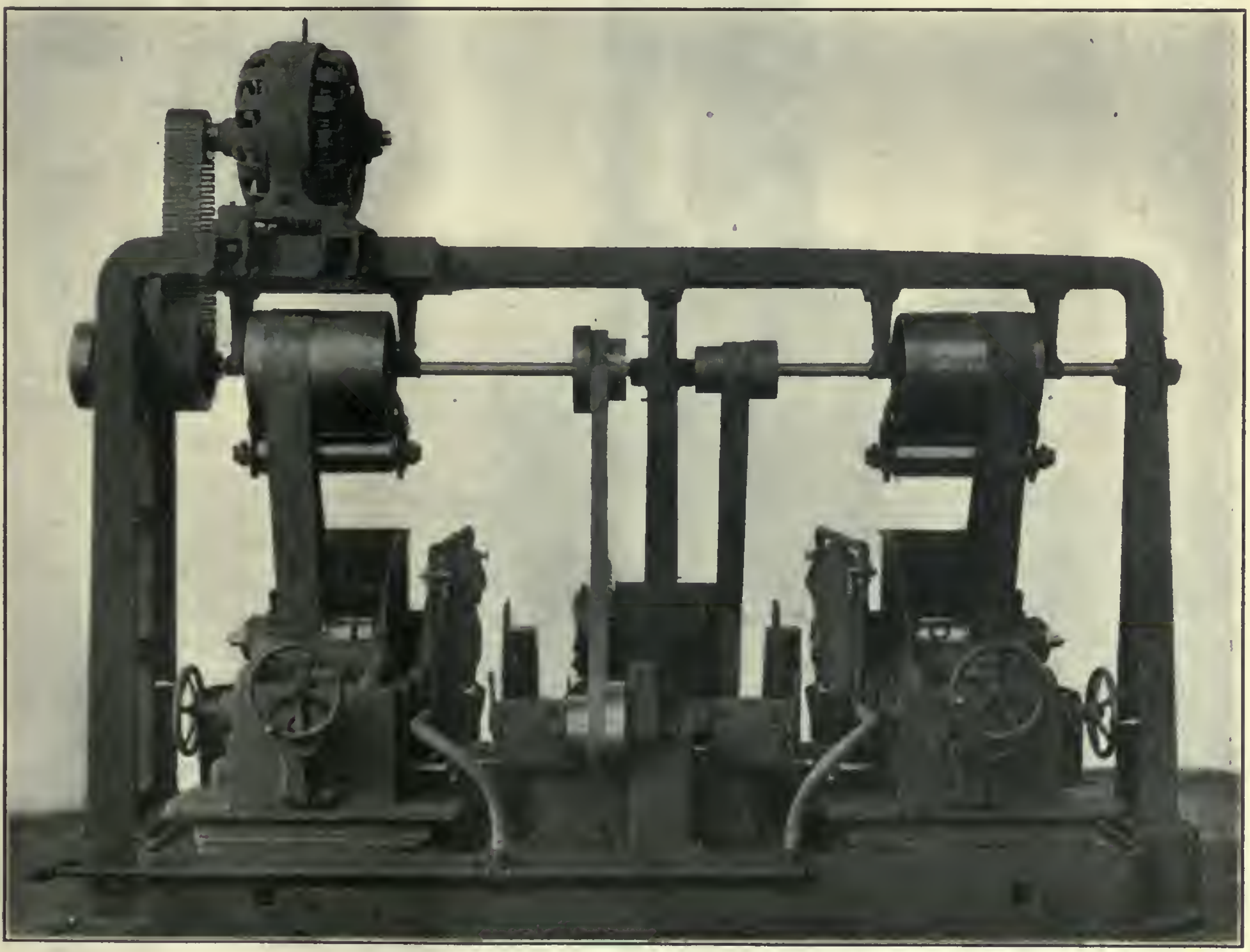
Grinding Cast Iron Wheels

At the June convention of Section III Mechanical of the American Railway Association, Mr. C. T. Ripley, general mechanical inspector of the Atchison, Topeka & Santa Fe R. R., presented a strong plea for the practice of grinding cast iron wheels for the removal of flat spots and other inequalities. During the course of the discussion Mr. Ripley was subjected to a pretty stiff examination as to the results obtained and the cost of obtaining them.

He based his argument on the fact that cast iron wheels are now worth a great deal of money, and that any means of prolonging their lives is well worth practicing. The Atchison, Topeka & Santa Fe have been grinding wheels for the past ten years and find it to be one of the best saving propositions that was ever adopted on the road, and, during period of federal control a large number of wheels were ground for other roads, with no dissatisfaction as to the results. In fact many people think the ground wheel better than a new one, because it is truly round and has not as much tendency to slide flat.



SIDE VIEW OF MACHINE FOR GRINDING CAST IRON WHEELS.

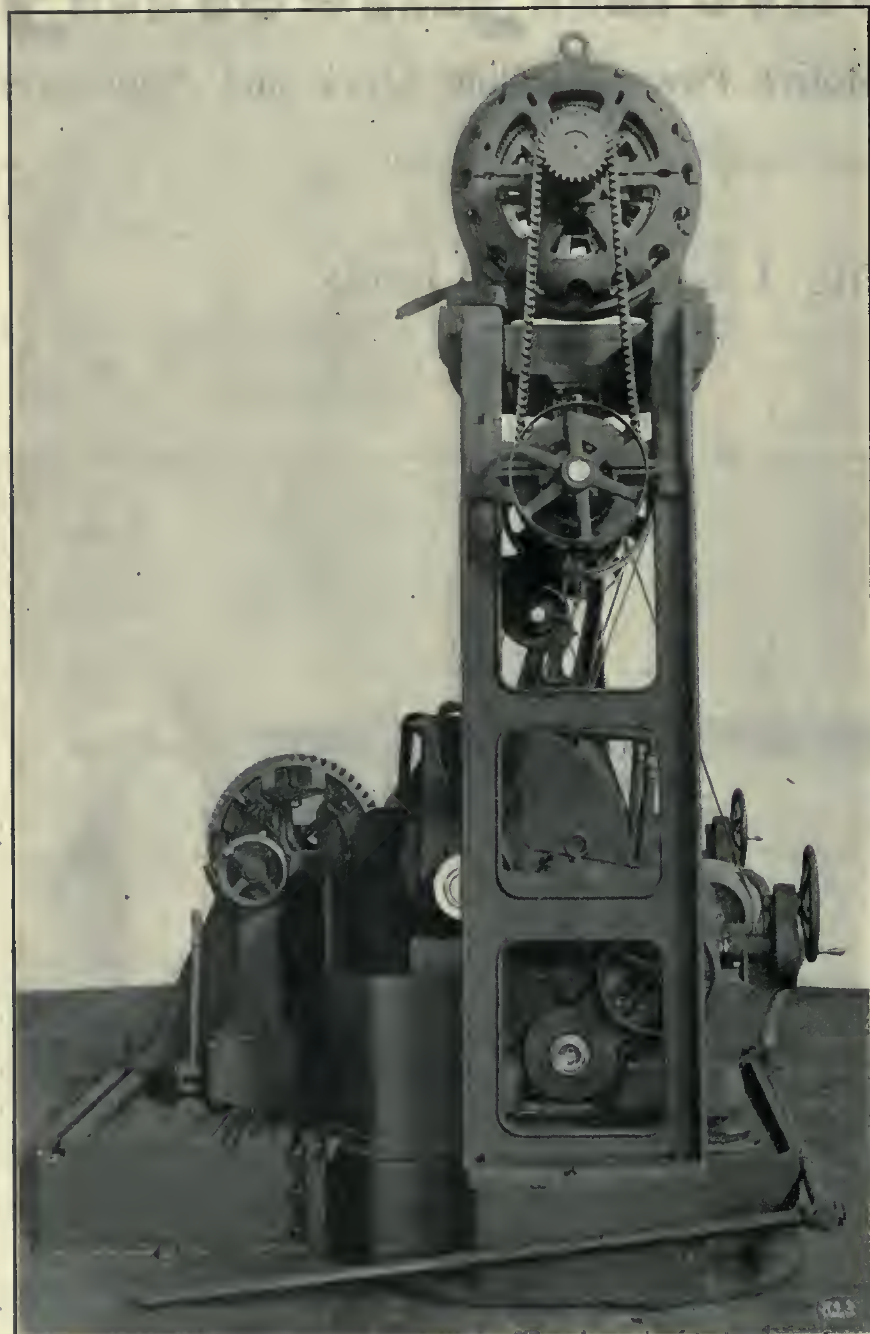
In starting the system of grinding, an investigation was made for the determination of the probable depth of chill. To do this a great many wheels were broken and an examination was made of the records of all inspections of drop tests and thermal test of wheels that were broken up at the plant. From this curves were plotted showing the chill in all kinds of wheels with different tape sizes. This chill was measured from the original tape size and the tape size at the time of grinding and tables were prepared showing exactly the length of slid-flat spots which can be ground. With the original tape size known and with the tape size at the date of grinding, a definite depth of chill is determined.

Mr. Ripley stated that he had personally gone over a pile of wheels in the shop and had never found a reground wheel that had been worn through the chill, simply because a proper selection was made of the wheels to be ground.

It must not be assumed that all wheels are suited to be reground, but with tables such as have been prepared, experienced men can easily select the wheels to be ground.

As to variations in the thickness of chill on two sides of a wheel, there is some but not much and the method used simply plays safe and does not run into them.

The tables referred to leave enough chill in the wheel so that not more than ¼ in. will be removed from the wheel, leaving from ⅜ in. to ½ in. of chilled metal, which is enough to avoid all trouble.



END VIEW OF MACHINE FOR GRINDING CAST IRON WHEELS.

As to the cost, Mr. Ripley placed it at 53 cents before the war. This included all overhead, depreciation and interest charges, in connection with the grinding of the wheel and the labor for handling and turning. At present the cost is about $1.

Later inquiry developed the fact that the Virginian R. R. is also making a practice of grinding slid-flat wheels at the Princeton, West Virginia, shops. Here they average from five to six pair of wheels in a day of eight hours. The cost is at the rate of 85 cents per hour or $6.80 for the day's work. At the rate of five pair a day the cost is only 68 cents per wheel, as shown from a careful tabulation.

Here, too, the work is entirely satisfactory and is regarded as a saving feature of great value. In this connection a reproduction is here made of the tables to which Mr. Ripley referred in his discussion before Section III-Mechanical. They cover the five allowable tape sizes and such reductions as may be made from the original by wear.

In the use of the tables it is assumed that the original tape size of the wheel to be ground is known or can be determined from the number of small lugs on the back of the wheel.

Wheels that are sent in for grinding are taped with the standard Atchison, Topeka & Santa Fe tape, when a note is made of the original tape size. Then by referring to the table under the original tape size and reading across from the actual tape size of the wheel as measured, the present diameter, circumference and depth of chill can be found.

Then, if the wheel is slid flat, the flat spot should be measured and under the column headed "Length of Flat Spot" the diameter and tape to which the wheel must be ground will be given.

The depth of the chill after grinding can be determined by referring to the chill corresponding to the reduced tape size.

For example, suppose a wheel sent in for grinding tapes to No. $\frac{x}{2}$. The table shows the diameter to be 32-51/64 in., the circumference 103.05 in. and the depth of chill 15/32 in. If this wheel has a 2½ in. flat spot, it will require grinding to a tape size of $\frac{x}{5}$ and a diameter of 32-45/64 in. This will leave the wheel with a depth of chill of 13/32 in.

Wheels with the tread worn can be ground if the measured tape size is shown in the left hand column of the table for the original size of the wheel. But in the case of wheels with flat spots, they must not be ground if the tape size and diameter necessary for grinding are under the heavy line in the table for the original size of the wheel.

Thus, a tape 3 size wheel can be ground down to tape $\frac{x}{8}$, which is also the limit for a wheel worn to tape $\frac{x}{4}$ and having a 2¾ in. flat spot.

The flanges of wheels that have been ground must not exceed the maximum allowance of 1⅛ in. in height; and, if they do, they must be ground down to that dimension.

In order to make the matter perfectly clear the following examples are given to show the results:

Slid Flat Wheel. An original tape 2 wheel which measures $\frac{x}{3}$ and has a 3¼ in. flat spot must be ground to tape $\frac{x}{7}$, or 32-39/64 in. diameter in order to do away with the flat spot. The chill, which was 9/16 in., is reduced by grinding to 31/64 in.

Tread Worn Wheel. An original tape 3 wheel which measures $\frac{x}{2}$ on retaping would grind to $\frac{x}{2}$ but could not be ground if the retaped size fell below the minimum, or $\frac{x}{8}$.

The machine used is one that represents the latest development in car wheel grinding machines and is manufactured by the Norton Co. of Worcester, Mass. As will be seen from the illustrations the machine is carried on a heavy base with an overhead frame to which the countershafting is attached and on which the driving motor is set. This leaves a clearing above the

TAPE 1 - ORIGINAL

Tape Size	Dia. in.	Circ. in.	Chill in.	Grinding Diameter for Slid Flat Wheels - Dimensions at Top of Columns Indicate Lengths of Flat Spots																											
				2"		2 1/4"		2 1/2"		2 3/4"		3"		3 1/4"		3 1/2"		3 3/4"		4"		4 1/4"		4 1/2"		4 3/4"		5"		5 1/4"	
				Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.
1	32 59/64	103.42	23/32	x/1	32 55/64	x/1	32 27/32	x/1	32 53/64	x/2	32 51/64	x/2	32 25/32	x/3	32 49/64	x/4	32 47/64	x/5	32 45/64	x/5	32 43/64	x/6	32 41/64	x/7	32 39/64	x/8	32 37/64	x/9	32 35/64	x/9	32 33/64
x	32 7/8	103.29	45/64	x/2	32 13/16	x/2	32 51/64	x/3	32 25/32	x/3	32 49/64	x/3	32 3/4	x/4	32 23/32	x/5	32 11/16	x/6	32 21/32	x/7	32 5/8	x/7	32 19/32	x/8	32 9/16	x/9	32 17/32	x/10	32 1/2		
x/1	32 27/32	103.17	43/64	x/3	32 25/32	x/3	32 49/64	x/3	32 3/4	x/4	32 23/32	x/5	32 45/64	x/5	32 11/16	x/6	32 21/32	x/7	32 5/8	x/7	32 19/32	x/8	32 9/16	x/9	32 17/32	x/10	32 1/2				
x/2	32 51/64	103.05	21/32	x/4	32 47/64	x/4	32 23/32	x/5	32 45/64	x/5	32 43/64	x/6	32 21/32	x/6	32 41/64	x/7	32 39/64	x/8	32 37/64	x/9	32 35/64	x/9	32 33/64	x/10	32 31/64						
x/3	32 49/64	102.92	41/64	x/5	32 45/64	x/5	32 11/16	x/5	32 43/64	x/6	32 41/64	x/7	32 5/8	x/7	32 39/64	x/8	32 37/64	x/9	32 35/64	x/9	32 33/64	x/10	32 31/64								
x/4	32 23/32	102.80	35/64	x/6	32 21/32	x/6	32 41/64	x/7	32 5/8	x/7	32 19/32	x/8	32 37/64	x/8	32 5/16	x/9	32 17/32	x/10	32 1/2												
x/5	32 11/16	102.67	19/32	x/7	32 5/8	x/7	32 39/64	x/7	32 19/32	x/8	32 9/16	x/9	32 35/64	x/9	35 17/32	x/10	32 1/2														
x/6	32 41/64	102.55	37/64	x/8	32 37/64	x/8	32 9/16	x/9	32 35/64	x/9	32 33/64	x/10	32 1/2																		
x/7	32 39/64	102.42	9/16	x/9	32 35/64	x/9	32 17/32	x/9	32 33/64	x/10	32 31/64	x																			
x/8	32 9/16	102.29	35/64	x/10	32 1/2	x/10	32 31/64																								
x/9	32 17/32	102.17	17/32																												
x/10	32 31/64	102.05	1/2																												

TABLE I. FURNISHING DETAILS OF MEASUREMENTS OF SLID FLAT WHEELS, ETC.

TAPE - 2 - Original

Tape Size	Dia. in.	Circ. in.	Chill in.	Grinding Diameter for Slid Flat Wheels, - Dimensions at Top of Columns Indicate Length of Flat Spots.																													
				2"		2 1/4"		2 1/2"		2 3/4"		3"		3 1/4"		3 1/2"		3 3/4"		4"		4 1/4"		4 1/2"		4 3/4"		5"		5 1/4"		5 1/2"	
				Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.
2	32 61/64	103.54	21/32	x	32 57/64	x	32 7/8	x/1	32 55/64	x/1	32 53/64	x/2	32 13/16	x/2	32 51/64	x/3	32 49/64	x/4	32 47/64	x/5	32 45/64	x/5	32 43/64	x/6	32 41/64	x/7	32 39/64	x/8	32 37/64	x/9	32 19/32	x/10	32 31/32
1	32 59/64	103.42	41/64	x/1	32 55/64	x/1	32 27/32	x/1	32 53/64	x/2	32 51/64	x/3	32 25/32	x/3	32 49/64	x/4	32 47/64	x/5	32 45/64	x/5	32 43/64	x/6	32 41/64	x/7	32 39/64	x/8	32 37/64	x/9	32 35/64	x/9	32 33/64	x/10	32 15/32
x	32 7/8	103.29	5/8	x/2	32 13/16	x/2	32 51/64	x/3	32 25/32	x/3	32 49/64	x/3	32 3/4	x/4	32 23/32	x/5	32 11/16	x/6	32 21/32	x/7	32 5/8	x/7	32 19/32	x/8	32 9/16	x/9	32 17/32	x/10	32 1/2				
x/1	32 27/32	103.17	19/32	x/3	32 25/32	x/3	32 49/64	x/3	32 3/4	x/4	32 23/32	x/5	32 45/64	x/5	32 11/16	x/4	32 21/32	x/7	32 5/8	x/7	32 19/32	x/8	32 9/16	x/9	32 17/32	x/10	32 1/2						
x/2	32 51/64	103.08	37/56	x/4	32 47/64	x/4	32 23/32	x/5	32 45/64	x/5	32 43/64	x/6	32 21/32	x/6	32 41/64	x/7	32 39/64	x/8	32 37/64	x/9	32 35/64	x/9	32 33/64	x/10	32 31/64								
x/3	32 49/64	102.92	9/16	x/5	32 45/64	x/5	32 11/16	x/5	32 43/64	x/6	32 41/64	x/7	32 5/8	x/7	32 39/64	x/8	32 37/64	x/9	32 35/64	x/9	32 33/64	x/10	32 31/64										
x/4	32 23/32	102.80	35/64	x/6	32 21/32	x/6	32 41/64	x/7	32 5/8	x/7	32 19/32	x/8	32 37/64	x/8	32 9/16	x/9	32 17/32	x/10	32 1/2														
x/5	32 11/16	102.67	17/32	x/7	32 5/8	x/7	32 39/64	x/7	32 19/32	x/8	32 9/16	x/9	32 35/64	x/9	32 17/32	x/10	32 1/2																
x/6	32 41/64	102.55	1/2	x/8	32 37/64	x/8	32 9/16	x/9	32 35/64	x/9	32 33/64	x/10	32 1/2																				
x/7	32 39/64	102.42	31/64	x/9	32 35/64	x/9	32 17/32	x/9	32 33/64	x/10	32 31/64																						
x/8	32 9/16	102.29	15/32	x/10	32 1/2																												
x/9	32 17/32	102.17	7/16																														

TABLE II. DATA OF MEASUREMENTS OF SLID FLAT WHEELS, ETC., CONTINUED.

machine so that it can be served by a crane if that is desired. In order to insure that the ground wheels are concentric with the journals they are revolved on the same while the work is being done. The work the face of the grinding wheel square and true. This traverse can be thrown out by one hand lever and the position of the wheels adjusted by the hand wheels shown on the outside of the wheel slides. revolution of the hand wheel advances the grinding wheel .04 in., which reduces the diameter of the car wheel being ground by twice that amount.

There is no hard and fast rule to be

Tape- 3 - Original

Grinding Diameter for Slid Flat Wheels - Dimensions at Top of Columns Indicate Length of Flat Spots

Tape Size	Dia. in.	Circ. in.	Chill in.	2" Tape	2" Dia.	2 1/4" Tape	2 1/4" Dia.	2 1/2" Tape	2 1/2" Dia.	2 3/4" Tape	2 3/4" Dia.	3" Tape	3" Dia.	3 1/4" Tape	3 1/4" Dia.	3 1/2" Tape	3 1/2" Dia.	3 3/4" Tape	3 3/4" Dia.	4" Tape	4" Dia.	4 1/4" Tape	4 1/4" Dia.	4 1/2" Tape	4 1/2" Dia.	4 3/4" Tape	4 3/4" Dia.	5" Tape	5" Dia.	5 1/4" Tape	5 1/4" Dia.	5 1/2" Tape	5 1/2" Dia.
3	33	103.67	9/16	3	32 15/16	1	32 59/64	1	32 29/32	X	32 7/8	X/1	32 55/64	X/1	32 27/32	X/3	32 13/16	X/3	32 25/32	X/3	32 3/4	X/4	32 23/32	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/8	32 37/64	X/9	32 17/32
2	32 61/64	103.56	35/64	X	32 57/64	X	32 7/8	X/1	32 55/64	X/1	32 53/64	X/2	32 13/16	X/2	32 51/64	X/3	32 49/64	X/4	32 47/64	X/5	32 45/64	X/5	32 43/64	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64	X/9	32 17/32		
1	32 59/64	103.42	17/32	X/1	32 55/64	X/1	32 27/32	X/1	32 53/64	X/3	32 51/64	X/2	32 25/32	X/3	32 49/64	X/4	32 47/64	X/5	32 45/64	X/5	32 43/64	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64	X/9	32 35/64				
X	32 7/8	103.28	1/2	X/3	32 13/16	X/2	32 51/64	X/3	32 25/32	X/3	32 49/64	X/3	32 3/4	X/4	32 23/32	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/7	32 19/32	X/8	32 9/16	X/8	32 1/2						
X/1	32 27/32	103.17	31/64	X/3	32 25/32	X/3	32 49/64	X/3	32 3/4	X/4	32 23/32	X/5	32 45/64	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/7	32 19/32	X/8	32 9/16	X/9	32 33/64								
X/2	32 51/64	103.05	15/32	X/4	32 47/64	X/4	32 23/32	X/5	32 45/64	X/6	32 43/64	X/5	32 21/32	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64	X/9	32 35/64												
X/3	32 49/64	102.92	29/64	X/5	32 45/64	X/5	32 11/16	X/5	32 43/64	X/6	32 41/64	X/7	32 5/8	X/7	32 39/64	X/8	32 37/64	X/9	32 35/64														
X/4	32 23/32	102.80	27/64	X/6	32 21/32	X/6	32 41/64	X/7	32 5/8	X/7	32 19/32	X/8	32 37/64	X/8	32 9/16	X/9	32 1/2																
X/5	32 11/16	102.67	13/32	X/7	32 5/8	X/7	32 39/64	X/7	32 19/32	X/8	32 9/16	X/9	32 35/64																				
X/6	32 41/64	102.55	25/64	X/8	32 37/64	X/8	32 9/16	X/9	32 33/64																								
X/7	32 39/64	102.42	23/64																														
X/8	32 9/16	102.29	11/32																														

TABLE III. DATA OF MEASUREMENTS OF SLID FLAT WHEELS, ETC., CONTINUED.

drive is from a three-step pulley on the countershaft through reduction gears, worm and wheel giving the three speeds of 6½, 8½ and 11 revolutions per minute, which gives a surface speed of 60, 80 and 100 ft. per minute on a 36 in. car wheel

The automatic traverse is also driven from a three-step pulley on the countershaft and can be made to run at a rate of 3.8, 5.6 or 7.5 strokes per minute. When the 5.6 traverse speed is used and the grinding wheel is being run at a speed of

followed in the selection of the grades and grains of the grinding wheels. This must be determined from the character of the car wheels themselves. In a general way a No. 16 combination grade N alundum vitrified wheel will give very satisfactory

Tape - 4 - Original

Grinding Diameter for Slid Flat Wheels - Dimensions at Top of Columns Indicate Length of Flat Spots.

Tape Size	Dia. in.	Circ. in.	Chill in.	2" Tape	2" Dia.	2 1/4" Tape	2 1/4" Dia.	2 1/2" Tape	2 1/2" Dia.	2 3/4" Tape	2 3/4" Dia.	3" Tape	3" Dia.	3 1/4" Tape	3 1/4" Dia.	3 1/2" Tape	3 1/2" Dia.	3 3/4" Tape	3 3/4" Dia.	4" Tape	4" Dia.	4 1/4" Tape	4 1/4" Dia.	4 1/2" Tape	4 1/2" Dia.	4 3/4" Tape	4 3/4" Dia.	5" Tape	5" Dia.	5 1/4" Tape	5 1/4" Dia.	5 1/2" Tape	5 1/2" Dia.	5 3/4" Tape	5 3/4" Dia.
4	33 3/64	103.80	17/32	3	32 63/64	3	32 31/32	3	32 61/64	1	32 59/64	1	32 29/32	X	32 57/64	X/1	32 55/64	X/1	32 53/64	X/2	32 51/64	X/3	32 49/64	X/4	32 47/64	X/5	32 45/64	X/5	32 43/64	X/7	32 5/8	X/8	32 37/64	X/9	32 35/64
3	33	103.67	35/64	3	32 15/16	3	32 59/64	3	32 29/32	X	32 7/8	X/1	32 55/64	X/1	32 27/32	X/3	32 13/16	X/3	32 25/32	X/3	32 3/4	X/4	32 23/32	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/8	32 37/64	X/9	32 17/32		
2	32 61/64	103.54	35/64	X	32 57/64	X	32 7/8	X/1	32 55/64	X/1	32 53/64	X/2	32 13/16	X/2	32 51/64	X/3	32 49/64	X/4	32 47/64	X/5	32 45/64	X/5	32 43/64	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64	X/9	32 17/32				
1	32 59/64	103.42	17/32	X/1	32 55/64	X/1	32 27/32	X/1	32 53/64	X/3	32 51/64	X/3	32 25/32	X/3	32 49/64	X/4	32 47/64	X/5	32 45/64	X/5	32 43/64	X/6	32 41/64	X/7	32 39/64	X/9	32 37/64								
X	32 7/8	103.29	29/64	X/2	32 13/16	X/2	32 51/64	X/3	32 25/32	X/3	32 49/64	X/3	32 3/4	X/4	32 23/32	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/7	32 19/32	X/8	32 9/16										
X/1	32 27/32	103.17	7/16	X/3	32 25/32	X/3	32 49/64	X/3	32 3/4	X/4	32 23/32	X/5	32 45/64	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/7	32 19/32	X/8	32 9/16												
X/2	32 51/64	103.05	13/32	X/4	32 47/64	X/4	32 23/32	X/5	32 45/64	X/5	32 43/64	X/6	32 21/32	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64																
X/3	32 49/64	102.92	25/64	X/5	32 45/64	X/6	32 11/16	X/5	32 43/64	X/6	32 41/64	X/7	32 5/8	X/7	32 39/64	X/8	32 37/64																		
X/4	32 23/32	102.80	5/8	X/6	32 21/32	X/5	32 41/64	X/7	32 5/8	X/7	32 19/32	X/8	32 37/64	X/8	32 9/16																				
X/5	32 11/16	102.67	23/64	X/7	32 5/8	X/7	32 39/64	X/7	32 19/32	X/9	32 9/16																								
X/6	32 41/64	102.55	21/64	X/8	32 37/64	X/9	32 9/16																												
X/7	32 39/64	102.42	5/16																																

TABLE IV. DATA OF MEASUREMENTS OF SLID FLAT WHEELS, ETC., CONTINUED.

or 55 ft., 73⅓ ft. and 91⅔ ft. for a 33 in. wheel.

The wheel slid bases can be adjusted to bring the grinding wheel spindle parallel to the angle of the tread, and a power traverse is provided to traverse the wheels across the width of the tread. This keeps

880 revolutions per minute, the traverse feed is about .008 in. for each revolution of the wheel, or about 7 in. per minute.

Of course the two grinding wheels are under a separate control. The wheel feed is through a hand wheel and reduction gears and a 5 pitch Acme screw. One

service and a No. 16 grade S crystolon vitrified wheel will do the same for cast iron wheels. Such wheels should be 24 in. in diameter when new and should be run at about 880 revolutions per minute, which will give them a surface speed of about 5,500 ft. per minute. In order to maintain this surface speed the rate of rotation should be increased as the wheel wears, until, when the diameter is reduced run on to a two-step spindle pulley by which the two wheel speeds given above are obtained.

silent chain, 6 in. wide with a pitch of .9 in.

A number of these machines are in use

Tape - 3 Original

Tape Size	Dia. in.	Circ. in.	Chill in.	Grinding Diameter for 3116 Flat Wheels - Dimensions at Top of Columns Indicate Length of Flat Spots.																															
				2"		2 1/4"		2 1/2"		2 3/4"		3"		3 1/4"		3 1/2"		3 3/4"		4"		4 1/4"		4 1/2"		4 3/4"		5"		5 1/4"		5 1/2"		5 3/4"	
				Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.	Tape	Dia.
2	33 5/64	103.96	1/8	2.	33 1/64	5	33	0	32 63/64	2	32 41/64	0	32 15/16	X	32 59/64	Z	32 57/64	X/X	32 55/64	Z/1	32 53/64	Z/5	32 51/64	X/3	32 49/64	X/4	32 47/64	X/5	32 45/64	X/6	32 21/32	X/7	32 39/64	X/8	32 37/64
4	33 3/64	103.00	31/64	3	32 63/64	8	32 31/32	3	32 61/64	1	53/64	1	32 29/32	X	32 57/64	X/3	32 55/64	Z/3	32 53/64	Z/5	32 51/64	X/3	32 49/64	Z/4	32 47/64	Z/5	32 45/64	X/5	32 43/64	Z/7	32 5/8	X/8	32 37/64	X/9	32 35/64
3	35	103.67	15/32	0	32 15/16	1	32 59/64	1	32 29/32	Z	32 7/8	X/1	32 55/64	X/1	32 27/32	X/2	32 13/16	Z/3	32 25/32	X/3	32 3/4	Z/4	32 23/32	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/8	32 37/64	X/9	32 17/32		
2	32 61/64	102.84	7/16	2	32 57/64	X	32 7/8	X/X	32 55/64	X/1	32 53/64	Z/2	32 13/16	X/5	32 51/64	Z/5	32 49/64	X/4	32 47/64	X/5	32 45/64	X/5	32 43/64	Z/6	32 41/64	Z/7	32 39/64	X/6	32 37/64	X/9	32 17/32				
1	32 59/64	103.42	27/64	X/1	32 55/64	Z/1	32 27/32	Z/1	32 53/64	Z/0	32 51/64	X/3	32 25/32	X/3	32 49/64	Z/4	32 47/64	X/5	32 45/64	Z/6	32 43/64	X/6	32 41/64	X/7	32 39/64	X/6	32 37/64								
X	32 7/8	103.29	13/32	X/2	32 13/16	Z/2	32 51/64	X/3	32 25/32	Z/3	32 49/64	Z/3	32 3/4	Z/4	32 23/32	Z/5	32 11/16	X/6	32 21/32	Z/7	32 5/8	X/7	32 19/32	X/8	32 9/16										
2/1	32 27/32	103.17	25/64	Z/3	32 25/32	Z/3	32 47/64	X/3	32 3/4	Z/4	32 23/32	Z/5	32 45/64	Z/5	32 11/16	Z/6	32 21/32	Z/7	32 5/8	Z/7	32 19/32	X/8	32 9/16												
Z/2	32 51/64	103.05	23/64	X/4	32 47/64	Z/4	32 23/32	Z/5	32 45/64	X/5	32 43/64	Z/6	32 21/32	Z/6	32 41/64	Z/7	32 39/64																		
Z/3	32 49/64	102.93	11/32	X/3	32 45/64	X/8	32 11/16	Z/5	32 43/64	X/6	32 41/64	Z/7	32 5/8	X/7	32 39/64	X/8	32 37/64																		
X/4	32 23/32	102.80	9/16	Z/6	32 21/32	Z/6	32 41/64	X/7	32 5/8	X/7	32 19/32	X/8	32 37/64	X/6	32 9/16																				
2/5	32 11/16	102.67	19/64	X/7	32 5/8	Z/7	32 39/64	Z/7	32 19/32	Z/6	32 9/16																								
2/4	32 41/64	102.56	9/32																																

TABLE V. MEASUREMENTS OF SLID FLAT WHEELS, ETC., CONTINUED.

to 20 in. the speed should be 1,030 revolutions per minute.

The driving pulleys on the countershaft for driving the wheels are 18 in. in diameter, and the belts, which are 6 in. wide,

The motor recommended for the work is a 35 horsepower, constant speed motor running at a rate of 740 revolutions per minute. The drive from the motor to the countershaft is through a No. 35 Morse

and everywhere the economies obtained are approximately those given by Mr. Ripley before Section III Mechanical of the American Railway Association at the Atlantic City Convention.

Annual Meeting of the American Railroad Association

Marked Activity in Many Departments Approved

Over 300 representatives of American railways attended the annual session of the American Railway Association held in Chicago on November 17, 1920. R. H. Ashton, president of the association, presided. The Executive Committee's report showed that the following had been elected members of the board of directors, the vote for directors having been taken by letter ballot from among the 716 railroad representatives, operating 308,012 miles of railroad. The list of directors elected are as follows:

T. W. Beatty, President, Canadian Pacific; B. F. Bush, President, Missouri Pacific; W. R. Scott, President, Southern Pacific, Texas-La. Lines; A. H. Smith, President, New York Central Lines; W. G. Besler, President and General Manager, Central of New Jersey; W. H. Truesdale, President, Delaware, Lackawanna & Western; E. J. Pearson, President, New York, New Haven & Hartford; J. H. Hustis, President, Boston & Maine; W. W. Atterbury, Vice-president, Pennsylvania System; Daniel Willard, President, Baltimore & Ohio; Hale Holden, President, Chicago, Burlington & Quincy; W. B. Storey, President, Atchison, Topeka & Santa Fe; H. E. Byram, President, Chicago, Milwaukee & St. Paul; C. H. Markham, President, Illinois Central; C. R. Gray, President, Union Pacific System; N. D. Maher, President, Norfolk & Western; W. L. Mapother, Executive Vice-president, Louisville & Nashville; H. G. Kelley, President, Grand Trunk.

A resolution was adopted deprecating the efforts that are being made to make the use of the metric system compulsory. The committee reported that arrangements had been completed to include the American Association of Local Freight Agents and the several associations of railways systems throughout the country as new sections of the American Railway Association. Recommendations were also adopted favoring the recommendations of the Operating Division regarding the use of red fuses, signaling flags, blue metal flags for car inspectors, rules to cover the use of dimmers on electric headlights on locomotives in road service and changes in the standard form of detour regulations. The deputizing of crossing watchmen has also been taken under advisement with a view to thoroughly legalize grade crossing protection. In this regard a series of instructions has been formulated for the use of crossing watchmen and gatemen. The committee further recommended that particular attention be given to the hazards incidental at loading and unloading points in regard to explosives, casing-head gasoline, refining gasoline and other dangerous articles. Telegraph and telephone departments of the railroads were furnished with a list of specifications for their better guidance.

The Association approved the position of the Transportation Division that there should be no further changes made until the present rules and regulations had had a fair trial, and the absolute necessity of changes become apparent after a thorough investigation of data bearing upon the subject.

The Signal System had not completed its work of investigation, which is in the hands of twenty-one sectional committees, but considerable real progress has been made looking towards a unification of means and methods for improvement in which the manufacturers are heartily co-operating.

The work of the Mechanical Division was heartily approved, and the handling of the affairs coming into the hands of the division was left entirely to the Mechanical Section, the work of the section as shown at the last meeting at Atlantic City, together with the mechanical exhibits displayed, showing how thoroughly the section was performing its work.

The Purchase and Stores Division showed that many practical recommendations had been adopted and a marked increase in efficiency manifested since the adoption of the new book of rules, and also considerable economy shown, particularly in the reclamation of material, scrap classification, supply train operation and the prompt delivery of material.

The question of carriers' own representatives being permitted and encouraged in the inspection of perishable freight, such as fruit, vegetables and other perishable material, was favorably acted upon, and the transference of inspectors from one district to another as may be required in the course of the variation in the volume of traffic, was recommended. "The Standard Rules for Icing Refrigerator Cars" was pointedly called to the attention of the Perishable Freight Division, and copies of the rules are being widely distributed.

Addresses, chiefly on the transportation problems, were made by Mr. Ashton, Colonel Robbins and Mr. Barnes. In the course of his remarks Mr. Ashton pointed out that the Interstate Commerce Commission has expressed the desire that the railways themselves, as far as possible, should handle all matters pertaining to service. He praised the individual railways for the loyal support they have given through the Car Service Division within recent months, and emphasized the fact that only by working together as they have can they render unnecessary the direct exercise by the commission of the great powers over service given it by the transportation act. Mr. Ashton gave detailed statistics showing the great increases in efficiency of transportation which have been attained since the railways were returned to private operation and said that the record made by the railways in August in rendering an average of 557 ton miles of freight services per freight car daily was the best record ever made.

Colonel Robbins claimed that never were the railways of the country confronted with such a complex and difficult transportation problem as that by which they were confronted immediately after the termination of government control. He referred to the bad effects produced by the "outlaw" strikes and said that the improvements in the transportation situation effected since then were the results of wonderful work. He believed it had been definitely proved that the movement of freight cars in fleets from one part of the country to another to meet seasonal demands for freight transportation in periods of emergency was a good thing when properly supervised. Proper supervision required adequate machinery, and he believed that the Car Service Division of the association furnished the needed machinery and that the Division of Service of the commission would be glad at all times to co-operate with it. He urged that when individual railways felt that there had been injustice by orders of the commission or the Car Service Division they should send representatives to Washington to present the facts regarding their local conditions. The commission's Division of Service, he stated, intends to establish agencies in various parts of the country to keep in touch with transportation conditions and to co-operate with the shippers and the railways in dealing with congestions and car shortages. He made four recommendations regarding the future policy of the railways: First, maintain the Car Service Division; second, standardize reports regarding shippers' unfilled orders for cars; third, standardize methods of distributing cars as between the various railways; fourth, specialize on organizations to improve the handling of cars at division points and stations. Since 1908, he said, the car carrying capacity of the country had increased only 33 per cent, while the freight to be handled has increased 94 per cent. These figures show why it is so necessary to have better handling of cars. He believed that station agents if properly trained could do more than any other class of railway men to help the car situation by getting local shippers to load cars heavily, to load and unload them promptly, to route shipments intelligently and in other ways to make more efficient use of the cars available.

Mr. Barnes stated that the question presented to the railways, however, was whether they would through their own machinery handle the distribution of cars or fail to do so, and thereby make it necessary for the Interstate Commission to exercise fully the powers given it by the transportation act. The time had come when it was impossible for the railways individually to handle car service matters, and if as a whole they were to handle these matters themselves they must do so in constant contact with the regulating authorities. He expressed the opinion that railway equipment never again would exceed the requirements as it did before 1916, and that for this reason the closest co-operation by the railways in handling it would always be more important than it had been heretofore.

Notice will be given by the Board of Directors in regard to the exact date and location of the meeting place of the next annual session.

Checking Reckless Automobilists

No railroad of its size in America has done so much as the Long Island railroad to prevent accidents to automobolists. Over 300 grade crossings have been abolished at a cost of over $15,000,000. The remaining 600 will be eliminated as rapidly as the means to spare will permit.

About six years ago it was a common practice for automobile drivers on Long Island to break off between 150 and 200 crossing gates in the course of the year, while from fifteen to twenty other reckless drivers, in attempting to beat trains over the crossing, would run their cars smack up against the side of trains. In addition to these offenses, the railroad's records show that during the same twelve month period, scores of autoists had knocked down traffic signs at grade crossings, and hundreds of others drove across the tracks, despite the warning whistle of the engineer or motorman of the train, and the oral and written cautions uttered and displayed to view by special traffic officers and crossing watchmen.

The company is meeting the situation admirably; posters, signs, electric lights, advertisements, news articles, editorial writers, and even the benefit of clergy have been invoked in the good work.

The following speaks for itself in the way of results:

	Killed at Crossings	Injured at Crossings
1918	27	209
1919	10	29
1920 (seven months)	4	7

Highest Record on the Pennsylvania

The highest recorded volume of freight traffic ever transported in the history of the Pennsylvania Railroad System was handled during the month of October. Reports from all divisions, which have reached the General Offices in Philadelphia, show that during the month an average of nearly 24,000 loaded cars per day, or 167,461 per week, were forwarded to their respective destinations. This represents more than 870,000 tons of freight a day, or over 6,000,000 tons a week, loaded on the Pennsylvania Railroad, or accepted by it from connecting lines. The reports at hand for the month of November show still larger results owing in some measure to the favorable weather.

New Railways in Poland.

A group of seven railway lines totalling 838 miles have been proposed in Poland for the purpose of connecting the parts of New Poland into one railway system, and giving better communication with the west. On the basis of 128 tons to the mile, it would require 150,000 tons of rails and fittings for the construction of the proposed lines, besides an immense amount of material. A factory has been already purchased in Warsaw and operations are begun in repairing thousands of locomotives that are in bad condition.

Expert Opinions as to the Causes and Prevention of Locomotive Boiler Explosions

In keeping with the marked progress in the work of the safety first movement, as shown by the reports of the Bureau of Statistics, it is gratifying to observe the marked decrease in the number of accidents due to the failure of some part or appurtenance of the locomotive. At the recent meeting of the Traveling Engineers' Association A. G. Pack, Chief Inspector in the Bureau of Locomotive Inspection, presented an analysis of the causes of boiler explosions, together with recommendations looking towards their prevention that was worthy of serious attention.

In the course of his address Mr. Pack claimed that there has always been more or less dissension among railroad men relative to the cause of boiler explosions. It is well known that the primary cause of an explosion is because some part of the vessel is too weak to withstand the pressure to which it is subjected. The cause of such weakness is sometimes hard to determine. The violence which follows is, however, accounted for by well-established physical laws.

All matter, whether solid, liquid or gaseous, consists of molecules or atoms, which are in a state of continuous vibration, and the result of this vibration is heat. The intensity of the heat evolved depends upon the degree of agitation to which the molecules are subjected. The process of the generation of steam from water is simply an increase of the natural vibrations of the molecules of the water, caused by the application of heat until they lose all attraction for each other and become entirely repulsive, and, unless confined, fly off into space, but being confined, they continually strike against the sides of the vessel in which they are contained, thus causing the pressure which steam exerts when under confinement.

The generation of steam by the addition of heat is accomplished in two steps; heat added to water first increases the activity of the molecules, which is indicated by a rise in temperature. Heat which warms the water and causes the rise in temperature is called "sensible heat." When sufficient heat is added to water, its temperature continues to rise until about 212 degrees is reached, the temperature of boiling water under atmospheric pressure at sea level. The temperature of boiling water varies directly with the pressure to which it is subjected, the greater the pressure the higher the temperature, and under 200 pounds pressure, the boiling temperature is 388 degrees, while under a nearly perfect vacuum water boils, or becomes in ebullition and gives off a vapor, at 32 degrees, at which point ice is formed when exposed to atmospheric pressure.

A British thermal unit is the quantity of heat required to raise the temperature of one pound of water one degree, therefore it takes 180 units to raise one pound of water from 32 degrees Fahrenheit to 212 degrees. The water does not go into steam as soon as the temperature reaches 212 degrees, but on the contrary it takes 970 additional units of heat to force one pound of water into steam at the same temperature. This additional heat is used in forcing the molecules apart against their mutual attraction, or cohesion, and is known as "latent heat."

It will be seen from this that every pound of steam in the boiler at atmospheric pressure contains 1,150 heat units. As steam is generated and the boiler pressure increases the heat energy in the steam also increases until each pound of steam under 200 pounds pressure holds within itself 1,199 units of heat, and the temperature of the water in the boiler is increased to 388 degrees.

When shell sheets rupture or crown sheets fail, and the boiler pressure suddenly reduced to atmospheric, a tremendous amount of heat energy stored in the water is almost instantly released, and causes a large amount of water to suddenly flash into steam, while the volume of steam, which is then superheated, expands many times. The capacity of the boiler is then wholly inadequate to accommodate the increased volume of steam so suddenly generated, nor will the rupture permit it to escape fast enough to avoid a tremendous reaction. As a result of this reaction, we have the appalling explosions which are from time to time so forcibly brought to our attention.

The force of a boiler explosion is in proportion to the size and suddenness of the initial rupture, and the temperature and volume of the water in the boiler at the time of failure. The average modern boiler has a capacity of approximately 500 cubic feet of water below the crown sheet, and has a steam space of about 150 cubic feet. If such a boiler with 200 pounds of pressure ruptures from any cause, so as to suddenly reduce the pressure to that of the atmosphere, the released energy will amount to approximately 700 million foot pounds, and if the explosion took place in two seconds approximately 690,000 horsepower would be developed.

Fig. 1 shows the results of an explosion due to defective and insufficient crown bar braces. The crown sheet of the boiler was supported by 28 crown bars, 15 of which were supported from roof sheet by 17 iron braces ½ inch thick and 2 inches wide, together with one brace ⅜ inch thick and 1¾ inches wide, and 6 crown braces ⅞ inch in diameter. Thirteen crown bars were not supported from the roof sheet. Only five crown bar braces showed new break, and all others showed old break at eye of brace or broken pin.

FIG. 1—RESULTS OF BOILER EXPLOSION DUE TO DEFECTIVE AND INSUFFICIENT CROWN BAR BRACES.

Fig. 2 shows the result of an explosion

due to low water. The fire-box of this boiler was equipped with a combination chamber, the crown sheet of which was welded to the crown sheet proper, and it was through the opening made by the failure of this welded seam that the contents of the boiler escaped, causing the death of two men. It is believed that if this seam had not failed these fatalities would not have resulted. In this case the right hand bottom water glass was practically closed by the rubber gasket being squeezed over the end of the glass, which, no doubt, rendered an inaccurate reading. The inaccurate reading of this glass was also contributed to by the steam pipe connection being bent so as to form a trap for the accumulation of water. This accident forcibly illustrates the importance of properly applying and maintaining water-indicating appliances.

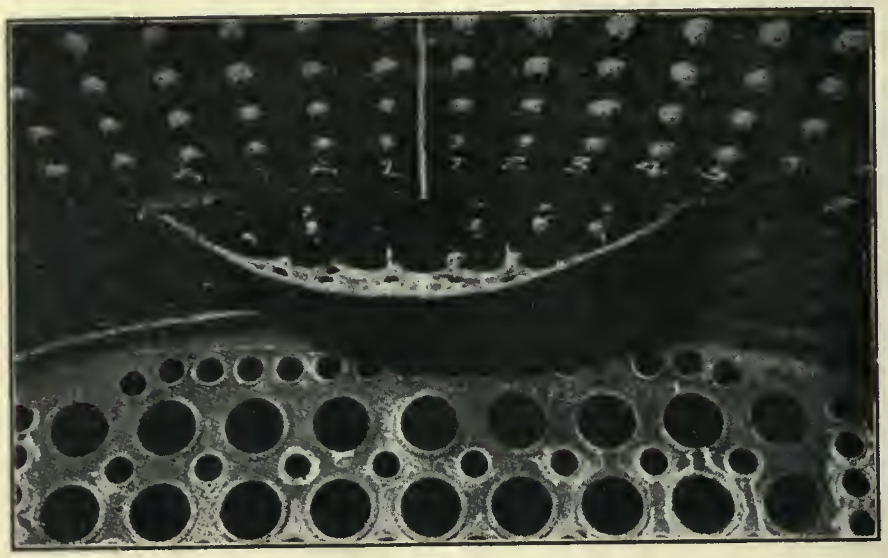


FIG 2. SHOWING RESULT OF AN EXPLOSION DUE TO LOW WATER.

As previously stated, explosions result because some part of the vessel is too weak to withstand the pressure to which it is subjected. This weakness may be caused by

1. Abnormal steam pressure.
2. Weakness in design or construction.
3. Improper workmanship.
4. Corrosion or wasting away of material.
5. Broken or defective stays.
6. Overheated crown or fire-box sheets.

A remedy for the first three causes is provided for in the law and rules, by requiring that the working pressure be fixed after careful consideration of each individual boiler by competent authorities and by fixing a substantial factor of safety for all parts of the boiler, to provide against hidden defects of material and construction.

To protect against failures due to corrosion or other defects caused by wear and usage, the law requires that regular inspections, both interior and exterior, be made and that all boilers be subjected to a hydrostatic test at regular intervals, and a sworn report to be filed with the District Inspector, showing the conditions found and repairs made.

In regard to overheating, it may be the result of scale or grease on the fire-box sheets or from low water. The fire-box sheets and tubes of a locomotive boiler are in contact with the fire-box gases, and would become heated at that temperature if it were not for the presence of water in the boiler. As already explained, the temperature of the water in the boiler depends on the boiler pressure, but rarely reaches a temperature greater than 400 degrees Fah.; therefore, while the plates are in contact with the water on one side, they cannot greatly exceed this temperature, although the temperature in the fire-box will exceed 2,500 degrees, which is about the fusing point of fire-box steel.

The heat in the fire-box is conducted through the plates to the water in the boiler where it is absorbed, the sheet thus being prevented from heating to the temperature of the burning gases. If, however, the transmission of the heat to the water is obstructed by scale or grease, or if the water fails to absorb the heat due to being light and foamy, the plates will retain the heat and may become red hot, or if the sheets are unprotected by water from any cause they become overheated. Metal loses strength when heated, and, if heated to a high temperature, has comparatively little strength to resist the pressure within the boiler, when, as a result, the sheets are forced off of the stays and failure occurs. It is a well recognized fact that scale or grease may be the direct cause of an explosion. Scale may indirectly cause an explosion by restricting or closing the openings of the fittings in the water-indicating appliances, thereby causing a false level of water to be registered, deceiving the engineman.

Railroad Ties on the Pennsylvania

Owing to the unprecedented levels to which prices of railroad cross-ties have risen in this Country, the Pennsylvania Railroad has decided to investigate the adaptability of the hard woods of Central and South America for this purpose. Inquiries have been started along several lines, not only to ascertain how much more cheaply ties, or the material for ties, can be purchased in those Countries, but also to investigate the question of the longer life of ties made from the Southern hard woods, as compared with those made from the North American native woods heretofore chiefly used. Under normal conditions the Pennsylvania Railroad System uses from five million to six million cross-ties annually. White oak, the most desirable North American wood for this purpose, is becoming rapidly scarcer. The other available woods in this Country have a very short life as ties, unless creosoted, which adds materially to their cost. The average net cost of railroad ties ready for placing in the roadbed has risen fully 100 per cent since the beginning of the war. Existing conditions now compel the Railroad to seek out other markets for the purchase of its supply.

A Blue Flag Derail

Blue protective flags are not always respected, but if the metal flag used on the Virginian Railroad is properly placed, there is no danger of its being disregarded unless it is willfully removed.

It consists of a simple and light derailing frog placed on one rail and projecting inwardly to the center of the track is a light rod carrying a blue metal disc at its end. It is placed from 35 ft. to 40 ft. from the car to be protected, so that a rapidly moving car or engine would be stopped on the ties before reaching the car protected.

Its only disadvantage is its weight which is about 25 lbs. But as the head end of the repair track is the place where they are mostly used, they do not have to be carried about very much, and so the weight is not so much of an objection as would at first appear.

Freight Train Mile Costs

The average cost of running a freight train one mile, as indicated by a comparison of the principal items of expense selected by the Interstate Commerce Commission for statistical purposes, was 23.2 per cent greater in July this year than in July, 1919. The total of the selected accounts was $1.89 per mile this year and $1.54 last year, an increase of 35 cents. In January the cost was $1.85 and in February, the last month of government operation of the railroads, it was $1.91, showing that the increase occurred before the return of the railroads, and that there has been a small decrease since.

The Relative Advantages of Modern Steam and Electric Engines

Abstract of Opinions By Expert Engineers

In the November issue of RAILWAY AND LOCOMOTIVE ENGINEERING we presented abstracts of addresses on the relative advantages of steam and electric locomotives delivered, as will have been observed, by four eminent engineers at a meeting of the railroad section of the American Society of Mechanical Engineers, and the Metropolitan section of the American Institute of Electric Engineers, in New York on October 22. In the discussion that followed the addresses, much new matter was presented, and many facts with which railroad men are already familiar, but in the hands of the accomplished engineering experts who took part in the discussion, the facts appeared in a new and larger light, and abstracts from the salient features of the discussion are of real interest, coming, as the matter that we are able to present does, from men so eminently qualified by education and experience to throw the fullest light on a question of such vital importance in regard to the future of the motive power employed in railroad transportation.

Abstract of Remarks by W. F. Kiesel, Jr., Mechanical Engineer, Pennsylvania Railroad, Altoona, Pa.

Mr. Shepard speaks of the transportation problem as a most serious one, the movement of traffic having fallen far behind, and expresses his belief that electrification is bound to be the most potent factor for its relief. For electric locomotives he claims greater power, speed, flexibility and mobility; intimates that under electric operation divisions can be much longer; and electric locomotives can be built to take any train which will hold together over any profile, at any desired speed, limited only by conditions of track and car equipment.

The same claim can truthfully be made for the steam locomotive. For either kind of operation, the length of divisions and location of terminals are governed by other than locomotive limitations, or, at least, there is no valid reason why any features of either electric or steam locomotives should affect the location of, or distance between, terminals.

In power, speed, flexibility and mobility, either type can furnish all that track and car equipment will permit. To illustrate this, your attention is directed to three recent locomotives: one built by the General Electric Co. for the Chicago, Milwaukee & St. Paul Ry., and described as being one that has a starting drawbar pull of 115,000 pounds, and a drawbar pull of 56,500 pounds, at 25 miles per hour on a two per cent grade; the other two were built by the Pennsylvania System—one is an electric locomotive, having two synchronous speeds (10 and 20 miles per hour), and the other a steam locomotive, with four simple cylinders.

Both Pennsylvania System locomotives have a drawbar pull, in starting, on level tangent, of 135,000 pounds. On grade the effect of truck and tender weight of the steam locomotive shows its influence, and the net drawbar pull, at 20 miles per hour at rear drawbar (calculated) of these locomotives is as follows:

	Electric.	Steam.
On level	81,000	83,375
½ per cent grade	78,000	80,350
1 per cent grade	76,000	77,125
1½ per cent grade	73,500	74,000
2 per cent grade	71,000	70,875

Furthermore, the steam locomotive can deliver more net drawbar pull than the Milwaukee electric locomotive, at any speed up to 50 miles per hour, and on any grade that it would have to encounter.

Mr. Shepard speaks of one locomotive as a generator of power and the other as a transformer of power coming from central stations with many refinements and high thermal efficiency. He credits the best steam locomotive with an average coal consumption of twice that of electric operation, for the same work performed.

The Pennsylvania System steam locomotive referred to has the same steam distribution system as that of a 2-10-0 locomotive, which has been fully tested on the locomotive test plant, and will burn no more coal per drawbar horsepower. The average coal consumption per drawbar horsepower of the locomotive tested on the plant was 2.7 pounds, for all firing rates up to 100 pounds per square foot of grate per hour, and 3.27 pounds for all firing rates from 100 pounds to 160 pounds per square foot of grate per hour. Locomotives seldom have to burn more than 100 pounds per square foot of grate per hour. These steam locomotives had no feed water heaters, the use of which—as proven by other tests—would reduce the amount of coal per drawbar horsepower appreciably.

Inquiries were sent to various electrified roads—not including those with only short transmission terminal operation—requesting the average cost in coal per kilowatt-hour at the power plant, the average efficiency of the transmission line from power plant to the locomotive, and the average efficiency of the locomotive.

One road, which has been operating electrically for a number of years, and records each month's operation, shows a power plant cost of coal per kilowatt-hour of 2⅝ pounds as the minimum when the plant output is maximum. Taking this as 100 per cent load factor, they show a cost per kilowatt-hour of 3.2 pounds of coal for a load factor of 50 per cent, and 3.53 pounds for a load factor of 40 per cent. Most of the monthly record figures lie between 35 per cent and 50 per cent load factors, and the grand average of coal per kilowatt-hour is above 3¼ pounds. These figures necessarily reflect both the daily and monthly variations in load factors and are, therefore, high.

Another road reports 40,000 to 44,000 b.t.u. per kilowatt-hour at switchboard for coal varying between 13,000 and 14,200 b.t.u. per pound.

Existing installations may be taken as approaching, but not yet equal to three pounds of coal of 13,500 b.t.u. per pound per kilowatt-hour at the power plant, a line efficiency of 75 per cent and a locomotive efficiency of 75 per cent, resulting in a consumption of four pounds of coal per drawbar horsepower hour. Therefore, the standby and other losses of the steam locomotive can be 32.5 per cent to equal the probable best average performance of present-day electric traction in coal consumption, and that much loss would be a sorry reflection on operating methods.

Mr. Armstrong also dwells on greater power, speed, flexibility and efficiency, and speaks of running a thousand miles with no attention, except by crews, and describes ideal characteristics of a locomotive, none of which apply to the electric locomotive in any greater measure than to a steam locomotive. The "precedent and prejudice" to which he refers seems to be imaginary. As he uncovers step after step of his flights of imagination, a gradually increasing desire for "facts" is felt.

Two statements in the fuel comparison deserve some analysis. The standby losses for steam locomotives are given as 9,042 pounds of coal. The regenerative braking on the electric locomotive is credited with a saving of 1,430 pounds of coal. About half, or 4,595 pounds of coal, of the standby losses, are for making fire and drifting, which is high. The coal used for making fire is not all loss. In ordinary service there will be no regeneration on upgrade, or on level, and probably none on down grades of less than one-half per cent. On steeper down grades the regenerative current must back the line current. Returning 18 per cent of current used, back into the line, appears high, and leads to the suspicion that Mr. Armstrong uses a comparison between a very bad steam operating condition, with a very good electric operation condition, which is not representative of averages. At present, steam locomotive standby losses are high, but, when railroads get back to normal, these losses will be materially reduced, and the average will no doubt be less than 15 per cent of the coal used. Regeneration may be a slight factor, but it will be nearly negligible in averages.

As tersely stated by Mr. Shepard, the substitution of electric traction will require a revolution in methods and service. The answer to the problem is governed by whether there is a saving in coal with electric traction over that with steam traction, including standby losses, and whether the saving is sufficient to pay interest, depreciation, taxes, insurance, etc., on more than 400 per cent greater capital investment, and for the interruption of traffic and the revolutionizing of the organization during the transition period.

Abstract of Remarks by H. B. Oatley, Locomotive Superheater Company, 30 Church Street, New York

Engineering literature during the past ten years has been well filled with very enthusiastic presentations of the advantages of electric traction. It would be futile to deny, to either steam or electricity, the credit of successful performance in the transportation of passengers, or freight. Little, if any, benefit can be derived from a discussion as to the relative merits of either of these two methods of traction, so far as the mechanical operation is concerned. Careful analysis of the question, by any engineer, will result in a unanimous opinion that, under certain conditions and in certain localities, electricity is superior—in fact, for terminal operation, such as we see around greater New York, is compulsory. Just as unanimous an opinion would be given for the operation of trunk line divisions, except that steam would be proven to be more advantageous, although quite possibly not compulsory.

It is futile to discuss fuel per drawbar horsepower, or maintanence cost per hundred engine miles, without some idea of what the return on the capital investment will be. The engineering public, as a rule, has no conception of what it has cost the railway company for the various electrified divisions about which so much has been said.

It may be well to consider the unusual position in which the railroad systems of the country now find themselves. Embarrassed and restricted by years of representative legislation, which often prevented the carrying out of constructive programs planned to safeguard future operation, then forced to undergo the trying and critical experience of government control, they are now facing a reconstruction period which must make up for a three years' hiatus in maintenance and replacements.

It is further to be noted that in a great many of the public utterances and public articles, dealing with main line electrification, and in which reference to, and comparison with, the steam locomotive has been made, the conditions of comparison equitable then are not fairly representative for the present day. These comparisons have too frequently been made between almost obsolete saturated steam locomotives, on the one hand, and the new and thoroughly up-to-date electric locomotives on the other. It is only fair to believe that the electric locomotives will be made more efficient, and it is only fair to insist that the comparison be with the modern superheated steam locomotive.

It is confidently believed that the improvements in the steam locomotives, many of which are past the experimental stage and are beginning to be applied as part of regulation equipment, will result in making the steam locomotive so much better, from a fuel and efficiency standpoint, that combined with the other points of advantage which it possesses it will be enabled to retain its superiority. The use of higher boiler pressures, multiple cylinders, higher degrees of superheat, traction increases, feed water heaters, etc., may confidently be counted upon to produce as great a proportionate reduction in fuel consumption of the present engine, as have the introduction of superheaters, brick arches, improved valve setting and compounding during the past decade.

The strongest argument of the electrical man is, probably, the one of maintenance cost of the electric locomotive proper as compared with the steam locomotive. While obviously, as is elsewhere pointed out, a true comparison must be between the cost of maintenance of steam locomotives, coaling and watering facilities, shop and roundhouse on one hand; and electric locomotives, powerhouses, transmission lines, transformer and converter stations, running and repair sheds on the other, it must, nevertheless, be conceded that the electrical engineer has done wonders in keeping the traction producing apparatus available for the transportation department during a maximum length of its life. It may be admitted that at the present time a larger percentage of the capital invested in traction producing apparatus is tied up by repairs in steam traction than in electric traction, and this is due to the thoroughness with which the electrical engineer has enforced the acquisition of all facilities necessary for the success of his apparatus. The burden of the proof that electric traction would be more economical than steam traction was placed by leading railroad officials, that were willing to undertake electrification, upon the shoulders of very highly developed engineering and manufacturing organizations, and they were undoubtedly allowed to take all reasonable precautions for preventing failure, irrespective of cost. Most of these railroad officers are operating men, and the electrical system was an entire novelty to them. They are, however, intimately familiar with practical possibilities of steam locomotives, through their own railroad experience, and while familiarity did not "breed contempt" it often bred abuse and a non-realization of the economic disadvantages resulting from such abuse. When the business of train-moving alone is considered, the old steam locomotive is quite flexible in its reliability; it will pull, not with best efficiency, but it will pull with worn valves and pistons, worn gear, pounding rods and boxes; and many are the instances in which retired steam locomotives were pressed into service much against the better judgment of the mechanical department.

Abstract of Remarks by C. H. Quinn, Chief Electric Engineer, Norfolk & Western Railway

Reference has been made to the 2-10-10-2 Mallet type locomotive on the Virginian Railway being of the same capacity as the electric freight locomotive on the Chicago, Milwaukee & St. Paul Ry. However, mention was not made of the fact that it was only by reason of the extremely wide side clearance obtained on the one particular road that such a steam engine could be used. Likewise, mention is not made of the fact that the engine could not be handled by its own power over any railroad, but had to move over a special route from the factory to the point of delivery.

If we are to accept the statement that the flexibility or mobility of the larger type of steam locomotive is unlimited, how are we to reconcile the fact that engines delivered by the builders during the period of the war, on account of limited clearance, could not be generally used on all railroads, but had to be operated on restricted sections of some of the roads where they were used? If we are to provide for the use of these larger steam engines on all railroads, the cost of bridge and tunnel work and possibly the rearrangement of clearances on some of our double-track railroads must be given consideration and the cost of same charged against the future increase in capacity of the steam locomotive.

In 1918, under similar operating conditions and dynamometer test run on a practically new 2-8-8-2 Mallet engine, weighing 695,000 pounds, with 472,000 pounds on the driving wheels, and equipped with superheaters, brick arch and stokers, gave a drawbar horsepower on 4.33 pounds of coal. The results obtained from the dynamometer test of these two engines in the hands of experts do not seem to indicate that the development of the steam locomotive along the line of fuel conservation has been very rapid.

If we will consider the 4.33 pounds of coal as being representative of the fuel per drawbar horsepower, for the larger type of steam locomotive it would not be amiss to compare these figures with the electric locomotive on the Norfolk & Western, as the operating conditions in all three cases are very similar. The above figures for steam locomotive converted into electrical terms, give 5.77 pounds of coal per kilowatt-hour, at the drawbar. Adding to this 23 per cent, which is a nominal amount for standby losses, we have a total of 7.12 pounds of coal per drawbar kilowatt-hour. During 1919, our Bluestone plant for traction purposes generated in round numbers 67,395,000 kilowatt-hours and burned 103,034 tons of coal, which is equivalent to 3.00 pounds of coal per kilowatt-hour at the switchboard. If you will consider a total loss between busbar and drawbar of 40 per cent as an average for electric locomotive of the size and weight that we are using on the Norfolk & Western, we have a coal consumption of 5.01 pounds per drawbar kilowatt, a saving of 2.11 pounds, or 29.3 per cent per drawbar kilowatt in favor of the electric over the steam engines. During this same period of twelve months we handled 4,714 east-bound trains and burned 103,034 tons of coal, which is a little less than 22 tons of coal per train, while using sacked fired Mallet engines in the same service and using sacked coal in a test, the total consumption per train equaled 35 tons, or an excess for the steam engine of 13 tons per train over the electric locomotive, as was shown during the series of tests.

The suggestion has been made that we consider from 25 to 50 years as the useful life of a steam locomotive and that during this time the policy of more activity be taken up on the part of the steam locomotive designer and builder in the direction of superheating and compounding of steam locomotives for the purpose of increasing its capacity. Might we ask what has become of the four cylinder and cross compound engines of thirty years ago and likewise the experience gained with compound engines during this period of time? If the benefits derived from compounding are not thoroughly understood after 30 years of experience, how can we expect the next 25 years to develop such data as will materially improve the situation as it now stands?

Reference is made to the handling of heavy tonnage trains as reflecting in peak loads on power plants and transmission system. In reply to this statement I may say that on the Norfolk & Western we handle our entire electric operation without any instructions from train despatchers and without any system of arbitrary train spacing. We have found our power plant and transmission system fully able to take care of 100 per cent more tonnage in a given space of time than had ever been handled by steam power. The projected use of the electric locomotive need not fear any failure or limitation from this source, if the installation is laid out with the same degree of latitude as is now in use in providing general facilities over the right of way and at terminals for steam power.

Further reference is made to some uncertainty in the functioning of the regeneration control of the electric locomotive. Like all other systems of braking, the regenerative system is susceptible to man failure. On the Norfolk & Western we are handling, in one direction, an average of 4,000 trains per year. We have had the electric locomotive in service about five years, and in that time we have handled over 20,000 trains, using only the regenerative apparatus to brake a 3,250-ton train down a 2.3 per cent grade. So far we have not had a man failure and the regeneration still has 100 per cent operation to its credit.

If our freight car carrying capacity can be increased 100 per cent in ten years, are we to be satisfied in considering the freight locomotive as having reached its maximum development? Is the railroad operating world as a whole going to be satisfied with the freight revenue obtained by using 100 per cent larger cars, and be forced to reduce the number of cars per train by the limitation of the steam locomotive? Do we expect our operating officials to be satisfied with the continued payment of premium overtime at the rate of $6.00 per hour for freight train crews, brought about by the slow movement of trains and the eight-hour day? As pointed out, the average engineer and train crew are held 25 per cent of their time at terminals. If we are to eliminate the ever-growing labor expense of premium overtime and reduce the standby losses of our locomotives, our running time per 100 miles must be reduced to five hours instead of eight, as is now about the best we can expect from the steam locomotive. If we are to approach this problem with the purpose of providing such motive power at the head end of our freight trains as will develop not only the drawbar pull up to the maximum capacity of the heaviest gear now in use, but such an engine as will sustain this pull at a speed that will permit train operation over a 100-mile division of varying profile within the time limit of the eight-hour day, we fail to find a steam locomotive record that will answer this specification. If there be any such record our attention has not been called to it.

Abstract of Remarks by W. L. Bean, Mechanical Assistant, New York, New Haven & Hartford Railroad, New Haven, Conn.

It must be conceded broadly that electrical operation requires less coal per unit of traffic handled than steam operation. How much less depends on the specific conditions. Likewise, the mileage per unit of electric equipment is ordinarily greater per unit of time. On one largely electrified road, express locomotives average 27 per cent more miles per day per locomotive owned than steam power in similar service. However, the first cost of the electric engines per unit of capacity was 84 per cent greater than in the case of steam. Therefore, the fixed charges are greater for the electric engine per unit of service.

A few words respecting comparative flexibility, especially in service of a character which demands it, may be of interest. A certain modern passenger electric locomotive will handle a heavy train of Pullmans at high speed on a through run with few stops, such as would require a modern Pacific type steam engine of about 43,000 pounds tractive effort. However, to operate the electric engine in heavy local service over the same distance is impossible because of the heating caused by frequent starting. In such service, the maximum train which can be handled by the electric locomotive can only approximate what can be handled by a steam engine of about 30,000 pounds tractive effort.

Realization of the extent of accumulation of wear and tear, both electrically and mechanically, makes it difficult to understand just how railroads are to maintain electric locomotives without back shops unless they job the work out to manufacturers of electrical equipment. Bearings wear, springs fail, axles and frames break on electrics as much as they do on steam engines. Switch groups, transformers, motors, both main and auxiliary, air compressors, blowers, control and collector apparatus, all require overhauling periodically. Officers in charge of maintenance of electrical equipment on one eastern road are at present insisting that $350,000 be expended soon for an addition to the present back shop.

Regarding the design of the machinery of a steam locomotive being utterly circumscribed by the necessity for tying it up to a steam boiler, the statement can be made that some modern high powered electric locomotives are so compact with apparatus, both inside the cabs and beneath, as well as on top, that additions to, or enlargements of details, even of a minor nature, are well-nigh impossible.

In surveying electrification broadly, one finds that there is a vast field of opinion among electrical engineers as to type of installations. Is it possible that by so many widely divergent electrical means the final net results are always to the discredit of steam operation? Can any type of electrical layout beat steam? Even if so, it is hardly probable that each electrical arrangement can be as good as every other one.

It appears that when a railroad goes in for electrification, it must settle on some type of lay-out, the main characteristics of which are fixed. Extension must either be along the original plan as to power characteristics, distribution or collector apparatus, or else vast sums must be spent to re-vamp the existing plant if the new lay-out is not to be largely separate and independent with all of the inherent disadvantages of non-interchangeability and lack of flexibility. The steam locomotive, except in a moderate way, as to clearances and weight limits, has a wide range of application. Railroads loan steam power back and forth with advantage usually to both parties, but no case comes to mind where electrical equipment for heavy traction can be interchanged, being tied up with a heavy and inflexible type of investment, which may quickly become obsolete through not lending itself reasonably well to extension or modernization.

Study and comparison of the details, item for item, of any large activity, is necessary in order to get the benefit of real analysis, but satisfactory conclusions as to the merits of the entire project cannot be reached by setting up, in a partisan way, outstanding advantages on the one hand, any more than by listing the disadvantages on the other.

Certain more or less intangibles are important and must be weighed impartially. Among such are the increase in real estate value through electrification, increased capacity of road, comparative safety and reliability of operation, permanence of type of design, obsolescence and depreciation factors, etc.

Tangibles from a money standpoint can and should be segregated and set up in full scope on both sides of the case and conclusions based on the net result at the bottom line of the balance sheet. If fixed charges on plant, including equipment, plus maintenance charges, plus other outgo, outweigh the savings in fuel, plus other operating savings, the net result is a deficit and all manner of proclaiming isolated pecuniary advantages would not induce a careful investor to support the enterprise.

Abstract of Remarks by George Gibbs, Chief Engineer, Electric Traction, Long Island Railroad.

As regards simplicity the self-contained steam locomotive has an inherent advantage over the combination of elements required for electric propulsion, and the latter must show some peculiar advantages in an operating rather than a structural sense, if it is to supersede steam traction. Furthermore, the steam locomotive has been developed to a perfection of detail and a high degree of steam economy during the one hundred years of its use; it does wonderful work, and is in possession of the field, representing a heavy money investment and can, therefore, be displaced (even by something better) only by slow degrees. So I think railway men can discuss this new rival of the steam locomotive with calmness and should cooperate with our enthusiastic electrical friends in giving their suggestions a trial; you never can tell what good may develop out of a thing, especially when one does not fully understand its possibilities. I speak as a steam railway-man—that was my bringing up, and I confess to a sneaking fondness for the reliable old "iron horse" and may be pardoned for frankness. But I am also sufficiently "in" with the new order of things to make plain speaking to my electrical friends proper and to suggest to them due modesty in making their claims. We want co-operation of both sides in the development of a useful new traction means. This is especially desirable now, as the paramount necessity of the country is more and better transportation. If it can be furnished through electric traction, in particular cases as a starter, we should konw it now.

It is, however, to the fundamental question affecting its adoption which I wish to draw attention: "Is the substitution of electric for steam haulage warranted by its advantages in the production of more transportation, and if so, is it practicable financially?" No sweeping generalization to the effect that electric traction will be used because it functions well will impress railway managers; they must have the answer to the above question.

Now, as regards the first portion of this query, it would appear that there are a number of important situations in which electric traction will produce results which cannot be had by the steam locomotive, notably in increasing existing track capacity, especially on lines having heavy grades, in yard shifting, in suburban and terminal services, and in locations (such as in tunnels) where the absence of combustion is necessary or desirable. Such installations should be undertaken if financially feasible, and this can only be determined by a critical examination of each case. Assuming that the money can be raised for an improvement which will pay, it will be found that electric stations will pay, directly or indirectly, in the special cases to an extent depending upon the density of traffic and the difficulty of maintaining proper steam operation. It must be admitted that an electric installation involves a higher first cost than for steam; in fact, its adoption means that more or less existing investment must be scrapped, therefore the increase in fixed charges must be offset either by the direct operating savings produced or these plus the indirect savings and benefits. The latter may mean avoidance of permanent way additions, a permissible change in operating methods, more traffic moved, and new kinds of traffic produced. The direct savings have been under discussion tonight; in spite of some differences in opinion, I think we cannot escape the conclusion that there is always a large saving in fuel with electric traction, generally some saving in maintenance cost of "power equipment" and often important savings in train crew costs, engine house expenses, minor supplies, etc.

Sometimes these "direct" savings will be sufficient to return a handsome profit over and above charges; if not, the indirect savings must be included. It will avoid disappointment if we face the facts; the electrification of the railways of the country as a whole, or the electrification of the whole of any extensive component system, is neither practicable nor desirable, measured by costs and results; the doom of the steam locomotive has not been sounded and will not be in our time. But the fact that electrification is not universally applicable should not discourage anyone; it has a very large and profitable field (both for the railways and the manufacturers). These facts indicate the importance of carefully investigating each proposed application to insure that it is properly conceived and carried out.

Remarks by F. H. Hardin, Chief Engineer, M. P. & R. S., New York Central Railroad.

In comparing the cost of maintenance or operation of electric and steam locomotives it must be remembered that in the steam locomotive a complete power plant must be maintained and operated, whereas in the electric locomotive there is merely the tractor. However, in computing comparative costs, from either the maintenance or the operating standpoint, it seems absolutely necessary to consider the proper proportion of the cost of operating the central power plant in electric service and also the cost of power. One phase of the question is whether the matter of cost is to be based upon existing conditions or the situation fifteen or twenty years hence. The railroad today must pay 7 per cent interest on money, and capital expenditure involved in the construction of power plants, substations and electric transmission lines would be enormous.

Mr. Armstrong makes suggestion as to certain things which the train despatcher might be able to accomplish with electric locomotives. If the present steam locomotives could be removed from the rails and replaced with electric locomotives of equal capacity, the question would be how often the electric locomotive could "deliver the goods" at the other end of the line without delay or failure as compared with what the steam locomotive now does. If the electric locomotive can be made to run 1,000 miles without change and without breakdown or diminished power the despatcher might accomplish a great deal, even with present cars, track facilities, etc., but there is more involved than merely replacing a Mikado or Mallet locomotive with an electric locomotive of equal capacity.

As to the statement that there is no need of the back shop for electric locomotives unless turning tires or painting may be considered heavy repairs, shops will be required, as electric locomotives must be heavy, so that drop pits, cranes and other shop facilities will be needed, even for running repairs. Ability to quickly substitute repair parts would be an advantage, but no one can tell how many kinds of parts would be required for the different kinds and types of electric locomotives which would exist after fifteen or twenty years of electric operation. Furthermore, the spare parts or repairs would have to be made in shops maintained either by the railroad or outside concerns. As to the quoted maintenance cost of 60 cents per mile for a steam Mallet, as compared with 14.65 cents for the St. Paul electric, costs on a New York Central division which used Mallets for most of its heavy freight trains in 1918 and 1919 amounted to from 21 cents to 25 cents per mile. These figures included some simple locomotives in operation on the same division. Some further figures covering back shop repairs of Mallet locomotives on two different divisions for the year 1919 showed averages from 12 to 19 cents per mile. Engine house maintenance cost is not readily obtainable, but may be assumed at not more than the shop cost per mile. Therefore, the total cost for the Mallet locomotive, including shop and engine house repairs, would be from 24 cents to 37 cents per mile.

Electric locomotives have been stated to cost possibly 50 per cent more than steam for equal driver weight, etc. In 1917 five modern 4-8-2-type freight locomotives cost about $205,000, about the same as one St. Paul electric locomotive. The five steam locomotives had total maximum tractive effort of about 250,000 pounds, whereas the one electric had only 115,000 pounds.

The solution of the railroad problem lies in obtaining the money to build, more than electrification or any other factor. As to present standards of train make-up, classification and terminal handling, as to which Mr. Shepard thinks that electrification will double the capacity of any railroad and, as methods are improved, double it again, electrification is only one factor in the solution of the problem and perhaps not the greatest one involved in accomplishing what Mr. Shepard sees in the future. As to the practicability of greatly increasing the speed of freight trains almost to that of superior trains, this undoubtedly means the improvements in freight car design also must be made.

Abstract of Remarks by Reiner Beeuwkes, Electrical Engineer, Chicago, Milwaukee & St. Paul Railway

As frequent references have been made in several of the papers to the Chicago, Milwaukee & St. Paul electrification, the writer wishes to correct mistaken impressions which might be derived from such references in Mr. Muhlfelds paper. Mr. Muhlfeld made a statement to the effect that "few, if any, existing steam roads can justify or stand the additional capital expenditure per mile of road for electrification, etc." This statement is supported by neither facts nor figures. It is not borne out in the case of the St. Paul electrification, and there are many roads with like conditions which might expect results similar to those which the St. Paul has obtained. That Mr. Muhlfeld's opinion does not represent the foregone conclusion of steam men in general is evidenced by the serious attention they have more and more been giving the matter of electrification.

In connection with the comparison between a Pacific steam locomotive and the St. Paul passenger locomotive the facts are that the electric locomotive is designed to handle, and tests have shown it capable of handling, a trailing load of not less than 960 tons over the profile, including the 2.2 per cent grade at the Columbia river. This is equivalent on the average to a train made up of thirteen of the St. Paul steel cars, or of fourteen cars of the average weight of the cars in the train mentioned by Mr. Muhlfeld.

Referring to Mr. Muhlfeld's comments on fuel consumption, fuel economy does not constitute the principal claim for electrification. This depends, in the individual case, upon the relative cost of delivering coal or electricity to the locomotive after all fixed and operating charges are considered. It may for such individual cases develop that the savings from electrification will be those due to decreased cost of engine repairs, engine house expense, train and enginemen's wages, increased ton-mile capacity of locomotives, etc. In the case of the St. Paul the power contracts apply for 100-year terms, and a fixed price for energy is thus assured. The figure of 40 kilowatt-hours per 1,000 ton-miles used by Mr. Armstrong represents an average for the whole year for trains of varying tonnages and under all weather and other affecting conditions. A corresponding figure based on special test runs as derived by Mr. Muhlfeld would obviously not be comparable. The comparable fuel figure for all trains and for the whole year for the district to which Mr. Muhlfeld refers could hardly be expected to run very high, as the average grade between the points mentioned is only about 0.06 per cent and the ruling grade only 0.8 per cent, as compared with the mountain grade conditions on the St. Paul. The steam equipment which was replaced by the electric locomotives has been stated to be antiquated or obsolete. The line of the St. Paul west of Mobridge has only been in operation since 1908 and most of the locomotives for it were purchased new. While most of the new locomotives were not of the most improved present-day type, they are probably representative of what is in general use by other roads.

Frequent references are made in the paper to improvements which are being or can be made in steam locomotives and steam operation which will make the average steam locomotive compare favorably in its performance with the electric locomotive. Steam locomotives have been used for a great many years and the electric locomotive is comparatively new. It is not too much to expect that the electric locomotive and electrical operation will also be progressing while the steam locomotive and steam operation are trying to catch up.

Concluding Remarks by E. B. Katte, Chief Engineer, Electric Traction, New York Central Railroad

The conservative railroad engineer, reflecting on the foregoing papers, will come to the conclusion that too much has been claimed for the steam locomotive as well as for the locomotive operated by electricity; without doubt, there are advantages peculiar to each, but it will always rest with the railroad engineer to determine and decide which type of locomotive will be best suited to the peculiar conditions surrounding the railroad which he serves. I will refer to but two points of comparison, namely, readiness for service, and comparative fuel consumption.

Readiness for Service.—Because of the different operating characteristics of steam and electric service it may be misleading to compare the time the locomotives are in use; for example, the electric locomotives of the New York Central R. R. operate only in a terminal zone, which makes the comparison with locomotives on steam operated divisions hardly a direct one. However, the following comparison of per cent of time ready for service, compiled from actual records for the first eight months of this year, will be of interest.

READINESS FOR SERVICE

Condition of Locomotive	Electric Locomotive. Per cent	Steam Locomotive. Per cent
(1) Ready for service—waiting.	56.2	24.3
(2) In service	31.3	47.8
(3) At terminals...............	3.0	4.6
(4) At engine house...........	8.5	23.3
	100.0	100.0

The fact that the electric locomotives stood waiting for service 56 per cent of the time and were actually in use only 31 per cent of the time, is due to the train schedule and the grouping of a large number of trains night and morning with comparative inactivity between these hours; and this clearly illustrates the necessity of carefully studying local conditions before coming to the conclusion that electric operation will prove more economical than steam operation for a given railroad proposition.

Fuel Consumption.—Unfortunately, a direct comparison applicable for all railroads between the coal burned on the steam locomotive and the fuel consumed in the power house for supplying energy to the electric locomotive cannot be made with the same accuracy as, say, between a reciprocating engine and a steam turbine; and this for the reason that there is not a representative steam division and an electric division operated under anything like the same conditions. The following comparison of fuel consumption has been computed from the reasonably accurate records of two railroads operating both steam and electric locomotives under widely different conditions both as to equipment and service:

COMPARATIVE FUEL CONSUMPTION, STEAM AND ELECTRIC

Items	C. M.& St.P.R.R.	N.Y.C. R.R.
Kw. hours per train mile measured at A. C. side substation..	29.1	34.5
Pounds coal burned on steam locomotive per train mile......	188.	112.
Pounds coal on steam locomotive equivalent to 1 kw. hour measured at A. C. side substation.	6.46	3.25
Computed pounds coal at power station per 1 kw. hour referred to A. C. side substation	2.44	2.44
Saving of coal in favor of the electric locomotive, per cent..	62.	25.

This wide range of results and the apparent discrepancy in the relative fuel consumption are not unexpected when consideration is given to the widely different conditions on each of these railroads. Even a wider difference in power consumption will be found on trains in different service on the same division, as, for instance, on the New York Central R. R., a multiple unit train making stops every mile or so will consume 150 watt-hours per ton mile, whereas the through trains making no intermediate stops in 30 miles or more, will consume but 26 watt-hours per ton mile. Here again is forcible evidence of the necessity of carefully considering the service conditions before expressing an opinion as to the relative advantages of steam and electric locomotives.

Finally, let me say a word of caution in regard to placing too much reliance on results obtained from test runs, notwithstanding the fact that they fairly well simulate actual conditions. To be of comparative value, service records should extend over a period of several years, the data carefully collected, correlated and averaged to give results that may be expected in every-day operation.

Canadian Pacific Railway Observation Cars in Europe

Upon the outbreak of war, the Austrian Government seized the very fine observation cars which the Canadian Pacific Railway had been operating in connection with the Austrian State Railways from Buchs to Vienna and Trieste through the entrancing scenery of the Austrian Tyrol. These cars were used by the Austrian Government during the war for some time as Red Cross carriages, and on the cessation of hostilities were handed back to the Canadian Pacific Railway in pretty good shape. Recently they have been sold by the Canadian Pacific to the Italian State Railways, and are now being operated by the Italian State Railways through many of the Italian beauty spots.

VIEW OF CANADIAN PACIFIC RAILWAY OBSERVATION CAR LEAVING ROME, ITALY.

They were used for the first time for a party organized by the Moroli Company of Rome for the transportation in Italy of the delegates of the National Council of Women of the United States proceeding to the International Feminist Meeting in Christiania. They left Naples on August 21, and proceeded via Rome to Florence, Venice, and Milan to Geneva, where they arrived on August 28.

Naturally the operation of these observation cars for the first time on the Italian State Railways created a great amount of interest and aroused intense admiration on the part of the people and the Railway officials, whilst the delegates from the United States declared that these cars were as elegant and comfortable as they had ever travelled on.

Tests of Pulverized Fuel on the Lehigh Valley.

From data recently furnished by the engineering department of the Lehigh Valley railroad in regard to the use of pulverized fuel on a Consolidation type of locomotive using saturated steam, it appears that full loads are drawn each day over a round trip approaching 90 miles with a fuel consisting of 58 per cent anthracite silt mixed with 42 per cent bituminous coal. The total amount of coal consumed is about the same as that used by similar engines burning soft coal in the same service. The saving per ton of coal is between $1.25 and $1.50 per ton or about $485 per annum with an installation capable of handling 1,000 tons of fuel daily. The steam pressure is maintained at 175 lbs. per square inch.

Lifting Chains.

Chains subject to constant or intermittent stress in time become granular in structure and very unsafe. For this reason more or less frequent annealing and testing becomes necessary if a chain has to be depended on to any great extent.

Tension Tests of Pipe Joints

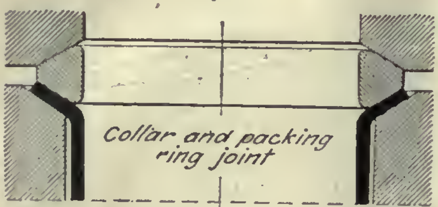
Determining Their Proper and Relative Strength

For several years the Northern Ry. of France has used two kinds of pipe joints on their locomotives in order to insure tightness. The diameters of the pipes vary from ⅜ in. to 10 in. The joints used are:

1. With collar and packing ring;
2. Expanded joint.

In order to determine the proper and the relative strength of these two types

Fig. 1



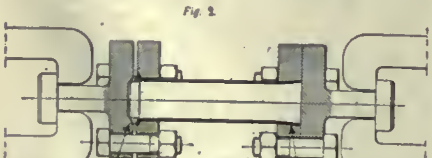
of joints, tension tests have been made with pipes of mild steel having an outside diameter of 2¾ in. and an inside of 2½ in.

As the type of joint is much more elaborate than the fittings used in this country, the accompanying illustrations showing the details of the French construction, as well as the result of the tests of the same should be of interest here because of the trouble that is experienced with the piping on locomotives. The data here given is from an article in the *Revue Generale des Chemins de Fer* by M. Bonniss, chief engineer of shops of the Northern Ry. of France.

The first tests made were with the collared joints.

The construction of this joint is shown in Fig. 1. It consists of placing a collar, which is bolted against a bronze joint ring, at each end of a 2¾ in. x 2½ in. pipe of mild steel. The whole was then set between two bridles, one of which was fas-

Fig. 2



Collar and packing ring joint — Smooth expanded conical joint

tened to one of the jaws of a testing machine. These bridles were made very thick and heavy and the general arrangement of the set-up is shown in Fig. 2.

The expanded joint is shown at the right of Fig. 2, and consists in rolling the pipe out into a conical hole in the collar.

The joint arrangement with the collar and joint ring was adopted because it was thought that the expansion of the pipe into the conical hole made a stronger joint than was necessary. But, contrary to all preconceived ideas, the expanded conical joint failed before the collar joint. In fact, the latter sustained a load of 20,800 lbs. without either collar or pipe showing any signs of deformation. The tube was then removed and made into an expanded joint, after having first been annealed so as to make it more malleable and suited to being expanded into the conical hole.

The tension test was then repeated and the relative weakness of this form of joint was shown by its yielding under a load of 19,600 lbs., while neither the tube nor the collar joint was distorted.

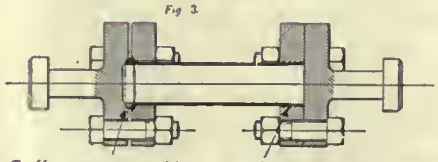
The conical expanded joint was then supplemented by cutting a series of channels ¾ in. wide and 0.1 in. deep around the hole, as shown in Fig. 4.

The tube, after annealing, was expanded and set up as in Fig. 3.

The collar was then pulled off under a load of 20,680 lbs.

When a pressure of 280 lbs. per sq. in. is applied to the interior of the pipe, the practical tension stress put upon the joint is about 1,200 lbs. So that, dividing

Fig. 3



Collar and packing ring joint — Conical expanded joint channeled

19,600 by 1,200, we have about 16 as the factor of safety of this joint.

Where piping is subjected to frequent expansion and vibration the root of the little collar may be subjected to reverse bending, that may cause cracking or even breaking. It, therefore, seemed reasonable, where the piping was subjected to this bending or vibration, to replace the collar joint by the expanded.

Tests were, therefore, made to determine the minimum dimensions of the collar for the expanded joint.

Knowing the poor results obtained with the conical expanded joint having smooth surfaces coupled with the difficulty of making them, attention was directed solely to the cylindrical expanded joints with channels, as shown in Fig. 4.

With a set-up as shown in Fig. 5 it was found that for a 2¾ in. x 2½ in. pipe a proper thickness of ring was about ⅝ in. In practice it has been found that such a ring is increased only a very slight extent in diameter under the influence of the expanding of the tube.

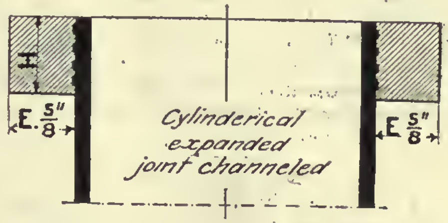
As to the length (H-Fig. 4) it was determined by other tests when the breaking stress was found to be

45,100 lbs. when H = 0.5 in.
47,080 lbs. when H = 0.8 in.
47,080 lbs. when H = 1.1 in.

In any case the limit of elasticity of the pipe would be greatly exceeded before the breaking of the joint would occur.

The results of the investigations show that the collar and joint ring construction

Fig. 4



with a factor of safety of about 16 on the basis of the stresses set up by internal pressures, fulfills all of the requirements of ordinary locomotive piping.

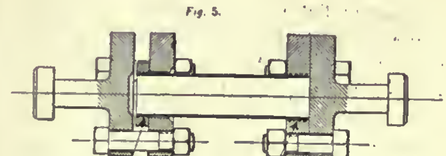
That the cylindrical expanded joint with channels which has a factor of safety of about 33 is best suited for piping subjected to internal pressures above those in general use on locomotives and where the piping is subjected to bending either as a result of the pressure or of expansion.

The final decision was the adoption of the collar and ring joint as the standard by the Standardization Committee of the French railways.

Improved Financial Condition of the Argentine State Railways

The Argentine Minister of Public Works has just made public his report

Fig. 5



Cylinderical expanded joint channeled — Conical expanded joint channeled

on the operation of the State railways for the year 1919. The report shows a better financial condition of the roads than for the year 1918, though the Central Norte is still operating at a loss. In speaking of this deficit, the minister explains that these lines were built for the purpose of opening otherwise inaccessible northern regions of the country, and therefore were not expected to pay at once, but will be profitable in the near future.

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The Working of Locomotives in the United States.

The characteristic feature of the operation of locomotives in the United States that impresses itself upon the visitor and which is fully realized by the men in charge, is the forcing and high pressure of work that is put upon them. It is a fixed principle in the minds of railroad managers that the locomotive is built to work, that it's destiny is to wear and not to rust out, and that it is not a profitable asset to have on hand a large lot of locomotives that are obsolete in design and, which even in a good state of preservation, are unable to do the work demanded by the traffic conditions of the present. This opinion is due to the development and exigencies of the past thirty-five years. Previous to that time it was common practice to assign a man to an engine and he alone acted as its runner. When he rested the engine rested, and when the engine was sent to the shop for repairs, it was not an uncommon thing for the engineer to take a vacation rather than run a strange machine. Under such conditions the man developed a real affection for the locomotive; he regarded it as his own personal property and would not overwork it. The result was manifested in the long life of the machine and the fine condition in which it was always kept.

The first step away from this state of affairs was in double-crewing, whereby, as soon as an engine was delivered by one crew it was cleaned and sent out again under another. This doubled the work which it was possible to get out of a machine, but destroyed that spirit of personal ownership and care and made the engine inspector a necessity. Then came the last step where the engines were put in what is known as the "chain gang," and where the first crew in is the first out and the same holds true with the locomotives, so that a runner may not be in the same cab twice in a month. Under these conditions the engines are not as well cared for, even cleanliness is apt to be neglected; and there is undoubtedly a much more rapid deterioration than in either of the other two ways. "Chain ganging" is not however, the universal practice, as the double-crew system is still extensively used, while upon small roads, and occasionally upon large ones, the single crew to the engine is still in use, but usually, though not always, because there is not work enough to keep the machine busy for greater lengths of time than the limit of a man's strength.

The over-working or over-loading of the locomotives is a recognized evil and one for which there seems to be little chance of change. The usual cycle of events, in the case of a passenger engine is about like this: The superintendent of motive power or a contracting builder is called upon to supply an engine that will perform a certain duty in hauling a given tonnage over a given division at a given speed. The engine is designed with a margin of power for emergencies and, when put to work, is found to meet the requirements of the case. Before it has been at work many weeks, it becomes convenient to attach one or two extra cars to the train that the engine is assigned to haul. It is found, to the satisfaction of all concerned, that it can take the increased load over the division on time and before long the extra cars become a regular complement of the train. Then a high wind, a slippery rail or a tank full of bad coal, or one more car of the president or a visiting magnate, makes the load too heavy for the locomotive and time is lost, and after that "behind time" is the regular order of the day. It is well within the mark to say that there are hundreds of trains on American railroads that are scheduled on such fast time and with such loads that it is impossible for the engines assigned to them to make the time except under the most favorable conditions. These speeds look very well on paper but in practice they do not work out and so flagrant is this defect in American railroad operation that it is taken as a matter of course, by regular travelers in the dressing room of a sleeping car, after a night's run that the train will be late, and a mild surprise is always expressed when it is learned that, "We are on time." It would be unsafe to say what percentage of through passenger trains arrive at their destination on time, but it is quite true that few superintendents would care to have the figures of their own roads made public.

Until within the last few years the same trouble was experienced in freight service, and there was no end of trouble given by engines becoming stalled on hills and being obliged to double back. Engines were loaded in the yards by guess and that guess was apt to depend more upon the amount of traffic to be hauled than the capability of the engine to haul it. This has been done away with to a great extent of late by the systematic analysis that has been made of the road. Ruling grades have been carefully considered and the tractive power of the locomotives determined, not only by theoretical calculations but by dynamometrical tests, with trains of varying weights and lengths hauled at different speeds. In these tests all influencing factors have been carefully considered, and the rating of the engine made such that there is no possible chance of stalling upon the road. This rating usually takes the length of the train as well as its weight into consideration, and is based upon the general principle of the greater weight for the fewer cars.

Usually, too, the analysis and rating is such that helping engines are required on all of the steeper grades. A concrete instance of the method adopted on a certain road will be of interest as illustrative of the method of handling traffic on this basis. The road, in question does a very heavy ore traffic in one direction, while the tonnage carried the other way is, by comparison, light. The length of the road is about 130 miles and in that distance there are eight sharp ascents, between which there are stretches of level track or short or easy grades. One class of engine used is of the consolidation (2-8-0) type weighing about 172,000 lbs., of which 156,000 lbs. are upon the driving wheels. The rating for these engines is based upon what they can haul over these level and easy stretches regardless of the heavy grades and is about 2,800 tons of 2,000 lbs. The result is that there are eight points between terminals where helpers are used. That is to say out of the total distance of 130 miles there are eight stretches aggregating about 35½ miles or a trifle more than 27 per cent of the whole, over which the regular road engine requires and receives assistance. The result is that the paying load over the road averages more than 1,000 tons per train, a condition that would be impossible were the helpers to be dispensed with and the road locomotive overloaded.

This system of rating and road operation obtains on many roads where there is a heavy traffic that must be hauled over adverse grades of comparatively short length. Of course there are several methods of rating based on the ideas of the management but the general principle of operation is the same, namely, that the road engine shall be worked to its economical capacity over the whole length of the division and receive assistance at special points of excessive resistance.

By this method of rating the cost of locomotive operation is reduced to a minimum and waste of power is obviated.

Until within the past few years the almost universal method of keeping locomotive accounts was on a mileage basis. That is to say the wages of the crew and the cost of oil, waste, fuel, repairs and supplies were divided by the total number of miles run and the cost per mile thus obtained was considered the basis of the cost of the locomotive operation. From this it might well appear that an engine with a light train would be much more economical in its operation than one hauling a heavy load as it would be. After a rather strenuous debate the Master Mechanics' Association adopted a resolution in 1902: "that the ton-mile is the best practical basis now available for motive power and operating statistics by which to judge the efficiency of locomotive and train service."

This recommendation makes the cost of hauling one ton one mile the basis of locomotive accounting and thus gives statistics on the cost of work done rather than distance run.

In regard to the length of trains hauled in this manner there is a wide variation dependent upon the character of the road. It rises from the six or eight cars of the mountain roads of heavy grades to a hundred or more upon those that are level. From 40 to 50 cars loaded to 60,000 lbs. each are common train loads, while the number rises to twice that with a string of empties. The speeds of freight trains are also subject to wide variations. Sometimes an attempt is made to limit them to twenty or twenty-five miles an hour, on other roads there is no limit and runs over short distances at from forty to fifty miles an hour are common. Indeed, where a limit is imposed, it is difficult to control the matter and runners will exceed it between stations on favorable grades. There is, however, much less stringency in the matter of speeds since the air brake has been extensively applied to freight cars than there was before that time, since control is given that was impossible when the brakes were applied by hand; still, in spite of this, the average time of the ordinary freight train over a division, including stops, is slow, and will not be much more than ten or twelve miles an hour; due, for the most part, to the fact that trains are run as extras, and are frequently held at sidings for long intervals for the passage of regular trains.

The length of the divisions into which the road is divided depends more upon the location of its important towns than upon any determination of the proper length of the run for a locomotive. In a general way it may be stated that 150 miles is considered a good economical length for a division, both from the standpoint of engine operation and the physical capacities of the men. As examples from actual practice let us take the Pennsylvania from New York to Pittsburgh, and the New York Central and Hudson River from New York and Boston to Buffalo. Between New York and Pittsburgh the lengths of the divisions are 89, 105, 132 and 117 miles, respectively. Between New York and Buffalo they are 146, 144, and 149 miles, while between Boston and Albany they are 99 and 103 miles, respectively. When a crew takes an engine from the main terminal it frequently makes a round trip over the division before it is relieved, so that the period of service, including the period of rest at the outer terminal, runs from eighteen to thirty-six hours.

The general scheme for the care and maintenance of locomotives is about as follows: The runner, or engineer, is expected to report all defects, that may appear upon road, to the roundhouse foreman at the end of the run; he also inspects the machine before leaving and after the arrival and delivers it at some specified point. From this place it is taken by the hostler to the cinder pit where the fires are cleaned, and thence to the coal pockets where the tender is filled with coal and water. At the home terminal it is taken to the roundhouse and wiped and sometimes this is also done at the outer terminal. The regular engine inspector goes over the engine very carefully and all necessary running repairs are made in the roundhouse. As to just how extensive these may be depends upon the road, the facilities at hand and the demand that there may be for power. Most roundhouses are provided with a lathe, a drill and a few other tools by which minor repairs can be made. The heavier repairs are made in the shops and are frequently divided into five classes:

1. General repairs, including new boilers;
2. General repairs, including new fireboxes;
3. General repairs, including new tubes;
4. General repairs, without boiler work;
5. Light repairs.

Reverting now to the forcing of the locomotives, to which allusion has already been made, the amount of fuel burned upon the grates varies with the quality, and this, in turn, varies with the location of the road. Coal is bought in the cheapest market and frequently the lowest priced in the market. Hence, as the coal areas of the United States are spread over an extensive territory, and their output ranges from the best in the world to the worst, it follows that the fuel furnished to locomotives covers an equal range of excellence and badness. Under the circumstances any figure that might be given could be substantiated or controverted, so only a general statement will be made for which no claim of universal accuracy can be set up. With this understanding, with a good quality of coal, a fair average rate of combustion might be placed at from 100 to 110 lbs. per sq. ft. of grate area per hour, and that this coal might be expected to evaporate from 5½ to 7½ lbs. of water per lb. In this bituminous coal is understood to be referred to. This is, in fact, the fuel of the country. A few roads leading into the anthracite coal regions of Pennsylvania burn the fine coal of that grade, and some other favorably located lines in Texas and California are able to afford the luxury of oil, while a few engines on two or three roads in Massachusetts are supplied with coke. But the main dependence for locomotive fuel throughout the country is the bituminous coal.

Turning now from the machines to the men who run them, we find these to be, as a mass, sober, intelligent, resourceful and reliable. The stress of modern railroad work is so severe, and the demands for constantly increasing speed are so great, that the roads are obliged to take every precaution that the men entrusted with the actual handling of this traffic shall be possessed of a sound mind in a sound body. The result is that for many years requirements have been made, both as to physique and habits, that were undreamed of in earlier days.

It goes without saying that the runner is promoted to the position after having served an apprenticeship as fireman, an apprenticeship that extends from one year to five, according to conditions and the fitness of the candidate. Among the requirements of the physical examination is that of the eyesight. The applicant is now almost universally examined, and not only for clearness of vision but for color-blindness, a condition that was not required at all thirty-five years ago.

These physical requirements differ on different systems, but the end and aim of them all is to procure a man that is strong, of good character and with irreproachable eyesight. In the matter of the use of intoxicating liquors, the rules have been growing more and more stringent. The time was when a locomotive engineer could get drunk with impunity when off duty, as far as the retention of his position was concerned, and even an occasional glass too much when in the cab would be winked at in the case of an otherwise capable man. But the demands for a clear head are now too great for that kind of work, and it is a common regulation that if a locomotive engineer or fireman is seen to enter a saloon, whether he is on duty or not, it will be considered a sufficient cause for dismissal. The result is a body of men, self-respecting and abstinent.

That this is characteristic of them as a class is shown by the conduct of the chance individual in emergencies. Under conditions that try men to the uttermost, these employes of the railroad will almost invariably be found true to their trust and the spirit of the captain who is the last to leave the sinking ship is found exemplified hundreds of time every year in the men who stand by their posts in the face of impending disaster and death.

There is also a spirit among them that takes a pride in displaying resourcefulness in time of accident or failure and the proud boast of many an engineer is that he was never "towed home"; but always managed to get his engine back under its own steam.

In concluding this short résumé of the methods of working American locomotives, it is not too much to claim that the life of both engine and man is a strenuous one, and that the aim of most officials is to relieve the latter as much as possible so that he may be alert and in the full possession of his faculties at all times, while, for the engine, it is the intention to keep it in good working condition, to the end, but that that end shall come and the remnant be committed to the scrap heap before it shall have outgrown its usefulness and become so obsolete in construction as to be uneconomical in action.

The Inexpediency of Nightwork

Anyone who has had charge of works in which nightwork is done must have noticed the very much smaller output at night as compared with that done during the day. Primarily, it must be taken that the average human machine is capable of producing a certain amount of effort between regular intervals of absolute rest, and preferably that rest shall be during the hours of darkness. To reverse the rest period sensibly reduces the inclination for effort; but, apart from this, resting during the day for the same length of time as during the night appears to be an impossibility with most men. The man on night shift must have a garden or some other occupation for part of the day at least, and he exerts effort on this which the dayworker conserves for his usual occupation.

Training Embryo Railway Employees on "Safety" Lines

It has often been mooted that the inculcation of "Safety First" precepts should commence in childhood. The London "Safety First" Council has ever endeavored to meet this need by schoolroom propaganda—games, films and attractive competitions. This year's essay competition drew from London and extra-Metropolitan schools alone upwards of 50,000 entries. Former competitions have dealt with street accidents and their avoidance. A new and more specialized competition has now been inaugurated by the council. Confined to the children of railway employees, it is calculated to become an intensive campaign against the enormous waste of life in railway accidents. These young people, by self-expression on "Safety First" in their essays, will be led to think "Safety." The majority of them are railway employees in embryo, and their value to the nation will be enhanced by reason of the fact that from childhood they have been trained in "Safety First" principles.

Colloidal Fuel.

We have previously noted the work done upon colloidal fuel by chemical engineers. It is generally conceded that since the processes devised under pressure of war emergency are applicable to various types of wastes, it would seem that colloidal fuels are sure to play an important role in the near future. If, as is claimed, such coal waste as culm, screenings, and dust can be used as well as peat, lignite and sawdust, such a compounded fuel is indeed of unusual importance. Colloidal fuels are a combination of such fuels, particles of which are reduced to a size to make them colloidal, held in emulsion form by soap-like substances. When dispersed in fuel oil, tars, etc., can be held in suspense with sufficient permanence to permit storing, piping, and burning the mixture with the same facility as fuel oil itself.

New Fuels on Railways

Important trials with pulverized coal and "colloidal fuels" have been carried out recently on the Great Central Railway, England. Colloidal fuel is powdered fuel suspended in thick oil, and pulverized coal is dry coal reduced to a fine dust. The trials, which were made in comparison with ordinary coal, showed that the special fuels could easily maintain a full head of steam with a high degree of superheat, even on heavy gradients and sharp curves. Locomotives adapted for burning pulverized coal or colloidal fuel show an economical freedom from ash-pan cleaning, smoke-box cleaning and repairs, fire cleaning, and so on. Further, when the locomotive is delayed in a siding there is much less waste of fuel than in the case of ordinary engines.

Eyesight.

Few people have perfect vision. Very few eyes are perfect, and although some people may have two perfect eyes, they may not be alike and therefore their resultant vision may be imperfect. But of people with these defects more than 90 per cent can have their vision restored to normal by being supplied with aids in the shape of glasses. Poor vision may be made good vision at a very moderate cost and will increase individual efficiency. Good lighting costs little more to install than poor lighting and costs less to maintain. Poor lighting can be made good lighting at less than 1 per cent of the payroll and will increase production from 6 to 12 per cent, reduce spoilage of product in many cases from 15 to 25 per cent, and lessen accidents from 20 to 30 per cent. Statistics show that only a little over 25 per cent have normal eyesight, and 17 per cent are normal in one eye but defective in the other.

Accumulations Reduced.

A new low record in the number of freight cars on hand in excess of current movement was made during the week which ended on November 5, when accumulations totaled only 32,665 cars, according to reports reecived by the Car Service Division of the American Railway Association. This was a reduction of 7,375 cars under the previous week. Cars held at ports with freight consigned for export or coastwise movement numbered 13,722 compared to 19,750 cars last week, or a decrease of 6,028 cars. While the reduction in accumulations is one of the evidences of increased efficiency on the part of the railroads in moving freight, part of the decrease this week, car service officials said, was due to a revised method of compiling this information by which a more accurate result is obtained.

Novel Use for a Locomotive Cab

The foreman of the car department of the Roanoke, Va., shops, of the Norfolk & Western Ry., Mr. J. D. Mayo, has appropriated a discarded locomotive cab for an office. That is about all there is of it. It stands at one end of the shop and is fitted with a desk, filing cases and chairs. It is as fresh and clean as paint and varnish and great care can make it. To which may be added the bright light of the sun by day and an electric lamp by night and newly cut flowers every morning. It has an inside measurement of nearly ten feet square so that it is commodious and comfortable. And when taken as a whole is really a model office when compared with any other accommodations whatsoever. This is an excellent illustration of making the most of such things as we happen to have, instead of waiting for all that we would like to have.

Snap Shots By The Wanderer

I was thrown in with a smiling, pleasant-faced foreman of a department in a big shop the other day and, on my introduction, was greeted with a warmth of welcome that even intimate acquaintances seldom mete out to one. The main portion of this sub-foreman's conversation consisted of praises of his general foreman, who, if this account were true, was one of the grandest, kindest, most considerate and ablest of men. There was nothing that he would not do for the good of his employes, and when it came to knowing his job he was all there. We were wandering down through the department at the time and the man's enthusiastic praise of his superior was most pleasant to listen to. Then we came to the speaker's office. It was as spic and span as the proverbial New England kitchen when set out on dress parade. Everything looked new and was polished until it shone, and on the desk was a vase containing a bouquet of flowers. I remarked on the general appearance of the place and how the flowers set it off. "Yes," continued the sub-foreman, "I do think they're mighty nice; I love the flowers, and it's fine the way they come. Every morning I have a fresh lot. The men bring them in. One will bring in a couple of clover blossoms, another a few sweet peas, some a rose, and they just reach in and stick them in the vase as they go by. I tell you I've just got the nicest bunch of men working for me that ever was, they, etc., etc.

Upon which I came to the conclusion that this foreman must be a very nice sort of chap himself. And later that is what the general foreman incidentally said of him, adding that he was one of the best workers on the premises.

It is the same old story. Ask a man how the world is using him and his reply will depend on how he is using the world.

This isn't much of a railroad story but it is mechanical enough to pass muster, and it is aptly illustrative of some parallel things that were done during the joy-inspiring period of government control. Things were pressing in France and the ordnance department in a certain city were ordered to gather together all pulleys possible and ship them forthwith. As no ordinary pulleys were obtainable a telegram was sent to Washington that they could not get any ordinary pulleys but they could get a quantity of split pulleys. Whereupon a prompt reply was sent from the supreme ones at Washington: "Ship the split pulleys, if they are not too badly split." There seems to be no place in the world so sure to harbor incompetents as some of the upper reaches of government appointive service.

Years ago, many years ago, the New York, New Haven & Hartford put up wide commodious parcel racks running the full length of their cars, and great was the comfort derived therefrom. For some inexplicable reason the good example was not quickly followed and it took very many years for it to permeate and become a part of regular practice and even now we still encounter the small narrow racks in coaches. But it has not yet touched parlor car construction. To be sure there are the long racks but they are too narrow to be of use for the large pieces of hand baggage.

This screed is inspired by a club car arrangement recently encountered. The car was used for parlor car service so that the hand baggage of all passengers was very much in evidence. The racks would carry only the smallest of hand baggage, and the chairs were placed side by side with their backs to the windows with a result that the whole space between them was filled with suitcases and bundles. I wonder whether the officers ever travel on these cars and, if so, con't they see what is needed? And why is this most comfortable arrangement so long in getting a footing on parlor cars in general.

I was walking along a heavy tonnage train with an inspector the other day, watching him lift one journal box lid after another, looking at the brakes and doing the general work of train inspector. He was calling attention to various things in and about the cars that he thought could be remedied, when he came to some badly distorted grab irons, when he suddenly asked: "What does all this safety first business mean, anyway?"

I tried to explain that it was a general movement on the part of railroad officials and other employes to increase care in all branches of service for the purpose of reducing accidents, a thing that is very desirable to accomplish, both from a humanitarian and financial standpoint.

"Then there ain't no law about it?"

"No."

"And the Interstate ain't taking no hand in it?"

"Only so far as to see that its regulations as to safety appliances are complied with."

"That's just it. Now I don't see why I ain't got a right to as much protection as a train hand. If I don't do my work proper they'd know it mighty quick. If that grab iron ain't fixed there's a row. But just look at the yard now. There's coupler knuckles, an' pins an' old brakeshoes scattered all along here between the tracks, and when it rains you wade through water six inches deep. I don't see why it ain't just as much of a safety first to get that there knuckle out of the way as to put that grab iron in the way."

I looked down the devil strip with its litter of discarded car parts, of lumps of coal, and ballast and an occasional stick or board, and could not help thinking that the man was right. And when I left him and walked towards the shops and was confronted with safety first signs on every hand and "Help make the X. Y. Z. one hundred per cent safe," I wondered if the man who ordered those signs painted and placed had ever taken a trip, with his car inspector, on a dark and stormy night along the devil strip between two long lines of freight cars in the yard across the way.

I was in two railroad yards the other day in the same town. The two roads paralleled each other for two or three hundred miles, and were engaged in the same kind of traffic. If working conditions were not the same it was because of the difference in the ideals of the management. In one yard there seemed to be an abundance of well distributed repair material. There were three or four brakeshoes on each devil strip for every rail. There were coupler knuckles and pins at frequent intervals and all set neatly on the ends of the ties, so as to be out of the way and not to interfere with the men as they walked between the cars. And when the stock became only slightly depleted a supply car, loaded with shoes, pins, knuckles, hangers, drawbars and levers was run through the yard and repair material distributed wherever it was lacking. The result was that no time was lost in going after material and the inspectors and yardmen were able to take care of any minor repairs that would otherwise necessitate the sending of the cars to the shop track.

In the other yard there was nothing. An occasional brakeshoe was scattered here and there, but it was usually in the pathway to serve as a stumbling block to the unwary. At night nothing could be found. The air plug was twenty-five car lengths from the engine, and could not be seen from it. The time allowance for inspection was so short that the men had no time to hunt up and apply brakeshoes and the like, though they could have done it had the material been handy. Hence cars were cut out and sent to shop tracks for minor bad order defects because it was easier to take the car to the material than the material to the car, and time was lost and expense incurred as a consequence. If the officials responsible would occasionally but take the trouble to talk with and listen to the men who do the work, it is probable that much wastefulness would be avoided and economies effected that are now allowed to go by the board.

The morning loafer (yes, that's a good name) in the smoking room of a sleeping car has been an unmitigated nuisance for years. How any man can sit around in the place during dressing hours is beyond comprehension. But they do, and it is not only the smoker but the non-smoker who has the habit. Porters have occasionally tried to clear the place, but with no success, and it has been a source of speculation for years why the railroads or the Pullman company have done nothing to relieve the situation. But now, at last, the Pullmans have posted a notice in a few of their cars that should be spread broadcast and made as conspicuous as type can make it. It reads as follows:

"To avoid congestion, passengers are requested to refrain from using this as a smoking room in the morning until after passengers have completed their toilet."

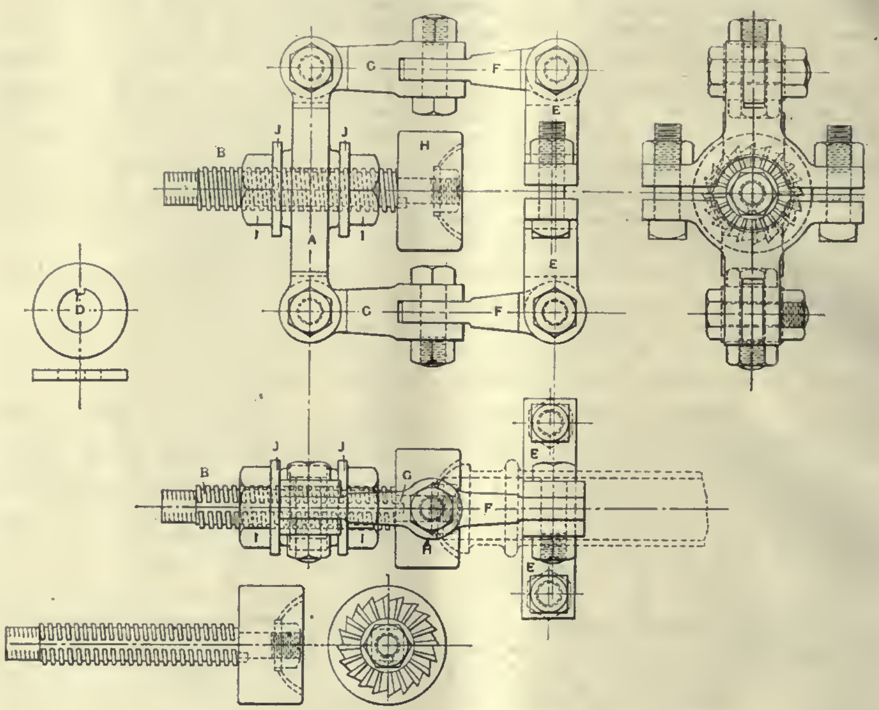
But why not post it in every car, and on all four walls of every room? If they can only eliminate the nuisance of the morning loafer they will have done a good and remarkable deed. and many there be who will rise and call them blessed. It only remains to be seen whether the unconscious loafer will consent to be eliminated.

Preparations for Winter.

We recently took occasion to call attention to the necessity of projecting the supervising mind into coming winter. Recent eccentric aerial phenomena has thrown the severest winter weather almost into the lap of spring but these variations are not to be depended upon. The winter is in many parts of the country now, and it is to be hoped that all the snow-fighting paraphernalia is ready for use and in serviceable condition. There are also all sorts of buildings to heat, roundhouses, car repair shops, oil tanks, stores and a host of others. Cars have to be efficiently cared for so as to be ready for the uncertain advance of intensely cold weather. Some prophesy a mild winter, but prophets are generally fools. He conquers who takes care, and it is better to look after the drainage pipes and reservoirs and receptacles about unused passenger coaches where drain cocks may have been open all summer, and yet may develop some mysterious frozen parts at a time that is doubly aggravating when the thought comes that it might have been avoided by a little forethought. Cars are frequently left standing on badly made and uneven sidings, capable of carrying them, but not on even keel, and the result is that water will with its mercurial faculty of finding the lowest spot in a pipe unexpectedly make its presence felt in a way that is sometimes astonishing.

Hand Miller for Superheater Units

Mr. Geo. H. Langton, superintendent of shops of the Virginia Railroad at Roanoke, has devised a very simple and handy miller for superheater units for which he has applied for a patent. The tool is clamped to and held by the pipe of the unit while it is in use, and it is so self-adjusting that the cutter is automatically brought to a proper bearing on the face of the unit seat. The whole is mounted on the pipe clamps EE which are fastened to the pipe whose seat is to be milled. At the ends of the arms of the clamps the connections FF are pivotted, and at right angles to the first pivot a second set of connections GG are pivotted. Finally these two are pivotted to the cross bar A. This cross bar is bored to form a bearing for the screw B. The lower end of this screw is rigidly attached to the milling cutter H whose cutting face is spherical and of the shape to which it is desired to bring the seat of the unit. It will be evident, from an examination of the drawings that the face of the milling cutter can assume any angle that may be desired and that when it is pressed down on the unit by the screw it will adjust itself to the surface with which it is brought into contact. As the cross bar A is bored smoothly the screw is worked back and forth through the nuts II. The washers I carry a projecting key D which fits into a keyway cut in the screw, so that they turn with it. When the adjustment is made by the nuts, so that the miller is pressed down against the unit, the screw and miller may be turned by hand or by coupling on an air motor. The fact that the washers beneath the nuts are turning with the screw prevents any tendency to creep and so press the miller against the unit or draw it away. In this way the seats may be faced or ground very rapidly and without necessitating their removal from the pipe.



DETAILS OF HAND MILLER FOR SUPERHEATER UNITS.

Freight Rate Increases Here and Abroad

The Bureau of Railway Economics computes the total advance in freight rates in this country, from 1914 to 1920, at 80 per cent. As compared with this, the estimated increases in some foreign countries have been: Austria, 390 per cent.; France, 140 per cent.; Holland, 70 to 140 per cent.; Norway, 150 per cent.; Sweden, 200 per cent.; Switzerland, 180 per cent.; United Kingdom, 101 to 114½ per cent.

Reading Gets Back Cars

The Reading continues to make progress in recovering actual possession of its own equipment, and on November 12 there were less than 32,200 of its cars on foreign lines, or 7,500 less than on March 1, when the railroads were released from Government control. Reading officials say they will continue their efforts to effect return of their rolling stock to their own tracks until the number operating over other lines has decreased to normal which seems assured in the near future.

Electrical Department

Testing Polarity of Field Coils for Electric Motors—Treatment of Waste for Motor Bearings

Electric motors operating on direct current, have, as we all know, field coils through which the electric current flows. These field coils surround the pole pieces and when the current flows through the coil, a magnetic circuit is formed for the operation of the armature. The reverse is true in the case of the generator; the armature revolves in the magnetic field and the current is generated.

It is very important that the field coils be assembled correctly, so that the various poles will bear a certain relation to each other. With the turns of the field in a certain direction around the pole piece, a north pole will result when the current flows. If the winding is put on the pole in the reverse direction, the south pole will be the result. The polarity of the poles alternates, that is, starting at any one particular pole if it is north, then the progression is made around the frame and the next one will be south, then north, then south, etc., depending on the number of poles. In most of the small motors for shop use, etc., the number of poles is generally four.

During the past few years the operation of the shop motors, etc., has improved greatly, due to the use of interpoles. These interpoles are small field coils placed around iron cores and located in the space between the main poles. The object of these interpoles is to give better commutation and thus improve the operation of the motor. The number of turns are such and the polarity such that any tendency to give an unbalanced condition electrically in the motor is offset and counteracted by the magnetic field formed by the interpoles. The polarity of the interpoles must bear a certain relation with the main field polarity, and it is important that the interpole coils be connected in the circuit in the proper manner.

A test should be made to determine whether the main commutating pole field coils are properly connected, preferably whenever the field coils are replaced, because the coils are sometimes placed over the poles inverted or reversed, and wrong connections thus made will show up in faulty operation of the motor. With the fields connected improperly, the condition might be such that an armature would run hot, due to an unbalanced magnetic field circuit, or flashing may result due to the commutating poles, either one or more being reversed.

Very little apparatus is required to make the test, namely, a polarity detector, such as a small compass or a magnetic needle, a switch and several frames of resistance. The circuit is arranged as shown in figures 1 and 2. Sufficient number of grids should be put in the circuit so that too large a current will not flow through the coils, causing damage. If too much resistance is inserted, the deflection on the polarity indicator may not be sufficient to give a good reading, and if this occurs, part of the resistance should be cut out. The method of procedure is as follows:

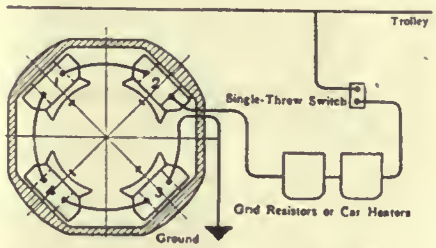


FIG. 1. CONNECTIONS FOR MAKING TEST ON MAIN COILS.

Connect all of the coils in series with the switch and resistance as shown in figure No. 1. When the switch is closed, current will pass through the field coils and, if properly connected, the polarity indicator will reverse at alternate poles. For instance, if No. 1 pole attracts the positive end of the indicator, No. 2 pole should attract the negative end, No. 3 the positive and No. 4 the negative. If these conditions are not obtained, it is known that some of the field coils are reversed or connections have been improperly made and should be changed so that the arrangement of polarity is obtained.

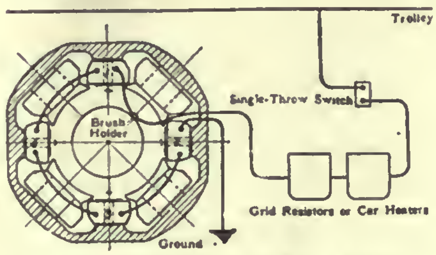


FIG. 2. CONNECTIONS FOR MAKING TEST ON INTERPOLE COILS.

If commutating poles are used in connection with the motor, two separate tests are necessary; one of which is as just described, and the other made on the commutating poles with connection as shown by figure No. 2. In the case of the commutating pole machine, it is important to have the proper relation of polarity between the main and commutating field pole. To properly check this, connect the negative armature lead of the motor to the positive field lead, the positive armature lead to the trolley side of the test circuit and the negative field lead to the ground side of the test circuit and close the switch. With the armature in the frame and the brushes making contact on the commutator, current will flow through all the windings. If the armature is not in the frame, then it will be necessary to have the circuit completed so that the brush holders be short-circuited. Under these conditions, the polarity of a main pole should be the same as the polarity of the commutating pole next to it in a crosswise direction, when facing the commutator end of the motor.

Many times interpole motors of four main poles do not have a complete set of four interpoles, but are fitted with two, located directly opposite each other. While the other poles do not actually exist, still the frame serves as the remaining two poles, so that the two interpoles must be of the same polarity.

Treatment of Waste for Motor Bearings.

Railway motors as well as some industrial motors are fitted with bearings having the method of lubricating the shafts and axles by means of oil and waste. Car journals are also waste lubricated and, to get the best results, the waste should be well saturated before it is packed in the oil wells. The saturation requires several hours, and the best results are obtained by following a certain definite procedure.

The waste should be wool waste, and of clean, long fibre material. The grade of oil should be a neutral mineral car oil. A good grade of waste will absorb about four times its weight of oil.

The waste should be placed in a tank or a can of oil and left to soak for at least twenty-four hours. The time required can be cut down if heat is applied and where a large amount of waste is used the soaking is done in an oil room which is heated up to a good room temperature. A very good arrangement is to build the tanks with a double wall, such that a hot water jacket can be used to keep the oil warm and at an even temperature. A temperature of 120° Fahr. is about the best temperature to obtain best results.

After the waste has been soaked for 24 hours, it is lifted out of the oil and placed on a screen and left to drain until all the extra or excess oil has dripped out. Twenty-four hours should be taken for the draining, after which the waste can be placed in closed cans ready for use.

A very convenient and efficient tank is shown by Fig. 3. The dry waste is placed in sections 1, 2 and 3, and fresh oil in section 5. By means of the pump at the right of the tank on top, the oil in section 5 is pumped into chambers 1, 2 and 3. After the waste has soaked for the 24 hours, the oil is drained back into section 5 and used over again when new waste is put into 1, 2 and 3. The sections 4 and 6 are used for resaturating old waste, so that the oil

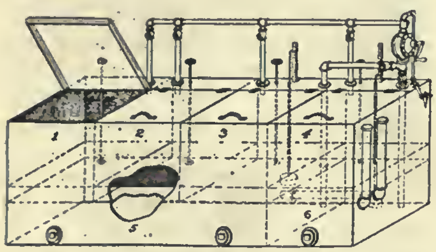


FIG. 3. TANK FOR SATURATING WOOL WASTE.

is kept separate. It will be noted that large clean-out plugs are provided for both oil chambers, and float gauges are also used to indicate the amount of oil in them.

We have seen how the waste should be treated before used. Hot bearings may be due to poor lubrication or to an inferior grade of oil. The right lubricant must be used, applied correctly and the proper amount. The bearing must be packed correctly as well. It has been mentioned above that a neutral oil should be used. Oils are either animal, vegetable or mineral. For bearing use in railway and industrial service a good grade of neutral mineral oil is required. It must be free from acid or alkali, as the presence of either will corrode the bright surfaces of the metal. The oil must be free from dirt and water. Water reduces the lubricating value of the oil, as it tends to wipe the oil from the journal. Particles of dirt and grit will increase the friction and, if excessive, will cause hot bearings.

In railway work it is the practice to use a different grade of oil for summer than for winter. The oil should be thick enough or heavy enough to cling to the waste and also to form a supporting film between the journal or bearing and the shaft. The degree of thickness of any particular oil changes with the temperature, so that it is customary to use a light or thin oil in winter, where cold weather exists, and a thick oil in summer.

France to Electrify Railways.

There are in France six great railway companies, and that known as the Compagnie d'Orleans was the pioneer in the electrification work. The programme is complete, and already has met with the approval of the State experts and the National Chamber of Deputies. In the Chamber only the Socialists opposed it. It has but to get the O. K. of the Senate, which is accepted as so nearly certain that work progresses even before it has been granted, to be put into full swing.

The scheme is based upon the utilization of the water power of the River Dordogne, which has been carefully surveyed and measured and will amount, when fully developed, to not less than 480,000 horsepower. That is a vast force. The electrification of the lines of the railway in question, though it be extended to the smallest switch and be designed to carry a mile-load a third greater than the road ever has carried under steam power, will need but 100,000 horsepower.

The railways to be electrified have an aggregate of 5,000 miles and the cost of electrification will be not less than two billion six hundred million francs. It is believed that the savings which will be effected by the application of the new power to the railways will amount, however, to a sum equalling an interest charge of 25 per cent. on this great sum.

Metals for Welding Operations.

Welding rods for iron and steel should be tested in the form of wire of a quality recognized as being suitable for welding, these should be subjected to the flame of the burner and the molten end examined carefully. When the flame is removed suddenly no craters should be visible on the metal and no "sparking" take place. Good wire should melt cleanly and smoothly.

A decisive test consists in taking a small piece of any sheet, which should be thicker than that which could be welded, bearing in mind the diameter of the wire to be tested. The sheet or plate metal is first heated, and the flame then directed on to the wire which is placed on the plate, so as to obtain a "worm" of molten metal formed by successive drops of metal which adhere to each other. This length of fused metal will be about 2 to 3 inches long and 1¼ to 3 inches thick, according to the diameter of the wire. The metal when cold is bent over in a vice. If the metal is of good quality, it can be bent right over until the jaws of the vice close upon it, without cracking unduly. Another test is to hammer the metal out at the ends, on an anvil, and this also gives an idea of ductility, especially if comparison is made with a standard test piece of recognized good quality welding material.

For cast iron, small test rods can be welded together, and compared with standard rings, by filing them. If the metal is easily workable and does not blunt the file, and is also free from blowholes and rough places, it is probably satisfactory.

Stack Hood for Tunnel

In our issue for November we illustrated a smoke conduit used on the Santa Fe type locomotives of the Southern Ry. on the Cincinnati, New Orleans and Texas Pacific Division between Danville, Ky., and Chattanooga, Tenn. As then explained this conduit was found to be necessary because of the large sectional area of those locomotives, which nearly filled the tunnel clearances.

On the smaller locomotives of the mikado (2-8-2) type a hood like that shown in the accompanying engraving is used very successfully. When running in the

LOCOMOTIVE EQUIPPED WITH HOOD FOR TUNNEL.

open the hood, which is of cast iron, occupies the position shown in the engraving. But, when passing through tunnels, it is thrown forward by an air cylinder and an operating mechanism so that it rests on the front edge of the stack and serves as a deflector to throw the escaping gasses back along the line of the boiler and project them over the top of the cab. They are thus prevented from striking against the roof of the tunnel and being thrown back downward and into the cab.

While this arrangement does not free the cab from smoke, like the conduit, it does serve to relieve the situation and make the cab more endurable than it would, otherwise, be.

Air Brakes for Sweden

As was mentioned in a former report, the Swedish private railroads have been reluctant to adopt air brakes, but it is probable that sooner or later they will follow in the footsteps of the State Railways. It would therefore be well for American manufacturers of air brakes to get in touch with the private railroad companies in Sweden, as it is quite certain that no German company can undertake to equip them at least for a year or two.

Suggestions for Greater Economy in the Repair and Maintenance of Steam Locomotives

By M. A. BLAIR, Instructor, Detroit Technical Institute

Manner of Performing Work

On nearly all roads, there is no instructions as to how much opening should be left in a cylinder packing ring to allow for expansion of the ring. Each machinist doing this work leaves what he thinks best; this ranges from nothing, to five-eighths of an inch. The packing with no provision for expansion of course does not last a trip and sometimes scores the cylinder badly. The engine may make several trips before the packing is again renowed, however, the packing was useless before the first trip was finished. Certainly much more coal is consumed. It is not uncommon for an engine to handle its tonnage for several trips with almost useless packing in both cylinders. It has been done on fairly stiff passenger runs. The allowance of five-eighths of an inch is entirely too much for the average cylinder and there is a constant loss of steam. There is a certain amount of opening that should be left in the rings, and there should be instructions covering this. Nearly all cylinders are of similar construction (simple engines) and the only factor that causes a variation is the cylinder diameter.

The machining or finish of parts at larger shops where it can be handled at a low cost together with standardization of parts will greatly aid the quick repairing of engines in round houses. This has been discussed by others, but a word here will not be superfluous. The air equipment is supposed to be standard but there is many sizes of pump governor cylinders with as many sizes of pistons and rings, and different sizes of reducing and feed valves bushings and pistons. Each of these can be a standard size. On some roads where there is instructions to this effect they are not followed.

The maintenance of air brakes in round houses is much more expensive than it should be. A great amount of air work now done in round houses is not necessary and much more of it should not be done there. The excessive use of oil in the air cylinders of pumps and the failure to drain main reservoirs are the causes of twenty per cent of the air work. This makes necessary the continual cleaning of the air heads of pump governors; feed and reducing valves, brake valves, and the smaller pipes. The distributing valve is usually cleaned frequently also, in spite of the fact that experience has proved the distributing valve is less subject to the evils of over-lubrication and moisture, than the other equipment. This is accounted for by the fact that the distributing valve is outside the cab and usually a sufficient distance from the fire-box to keep the oil from being carbonized by the heat. Feed and reducing valves should not be next to an uncovered boiler head, or even covered, if they can be placed elsewhere in the cab. The shortest pipes possible should be used from the main reservoir connection to the pump governor. In the larger round houses where an air man is kept on the work, repairs may be made economically, but in fifty per cent of the round houses parts should be changed and no attempt made to repair them. The repairs should be made in the air brake department of the back shop. A pump can be changed in the same time, that is necessary to renew packing rings, in one cylinder. much of the air brake work done in the round house is not satisfactory. There has been more pump governor cylinders made useless by cleaning and attempted repairs than there ever was repaired there: Generally the necessary repair parts are not carried in the store, and the average machinist does not know how to do this work. This refers to machinists who are not air-brake men. Usually the first thing they do, is crush the cylinder in taking it from the steam body and make it absolutely worthless until it has been reamed or bored. The upper portion or head of a governor may require cleaning in the round house, but the cylinder never does, and no repairs on this should be attempted, except by competent air-brake men. Distributing valves are cleansed and oiled very often; on some roads once a month. A distributing valve does not require cleaning more than once a year.

In the round house, quite often, packing rings a quarter of an inch in diameter, larger than the pump cylinder, are used. The machinist cuts a sufficient amount out of the ring to allow it to enter the cylinder. A pump with rings put in, in this manner can not compress air efficiently. The rings have a three point bearing and the pumps work continuously from the beginning to the end of a trip, to supply the system. To secure efficiency in this line of work, as much of it as is possible must be kept out of the round house and the men educated in this line to enable them to perform, intelligently, that work which is necessary in the round house.

Since the bulb headlight has been generally adopted, the lighting equipment has been very satisfactory; before, it was the reverse. With the late types of turbo-generators and bulb headlight and proper wiring system there should be very little trouble on the road or in the round houses.

No machine work should be done in the round house machine shops that can be avoided. On many roads there has been no effort for improvement in this direction. Heavy and light castings, forgings, and parts made from bar stock are finished at the round houses. In some cases the roads have a large back shop in the same city. One not knowing different, would think the back-shop, and the round house were owned by different companies. There is a certain amount of machine work that must be done at the round houses, but at least fifty per cent of what is now done there, can be handled in the larger back shops. The cost of machine work in round house machine shops and small back shops is from two to ten times what it should be in a fairly efficient larger back shop. Pop-valves, blow off cock valves, boiler check valves, relief or by pass valves, washout plugs, standard studs, wedge bolts, rod key bolts and many other things can be finished before being shipped to the round houses and small back-shops. Rod brasses can be planed to size, except the height and this to one thirty-second oversize, crosshead pins and knuckle pins can be finished to one-sixteenth over size. Even with the present lack of standardization much improvement is possible.

The successful management of any industry, or branch of same, depends to a great extent upon the co-operation of all the persons engaged in the work. The first move to obtain this must be made by the companies. They must make conditions such, that co-operation is possible. With few exceptions railroad companies will place a new device or an improvement on engines and take absolutely no steps to instruct minor officials, engineers and mechanics how they should be used and maintained. They will be operated and repaired in some manner but it is only guess work and blundering. Not over ten per cent of all skilled labor on railroads understand the parts of locomotives as they should. This lack of knowledge is very noticeable in connection with injectors, lubricators, headlights and generators, air equipment, stokers and air fire doors; and improved machine tools. Fortunately for employees who take an interest in these things and wish to understand them the manufacturers will always furnish information and drawings when requested. But the railroad companies do not even inform employees that they can secure information from the manufacturers, which would be little effort to secure more intelligent work.

Many roads have freight engines equipped with steam heat hose. Three hose on each engine. The hose deteriorate nearly as fast on the engine when not in use, as they do when they are in daily use. Often, freight engines are used in passenger service, but even when this is done between terminals, there is always steam heat hose available. As it is, when freight engines are tested for passenger service at least half of them have to be changed.

The idea advocated by these writings is to reduce the work in round houses to the lowest possible amount, but to not neglect any necessary work. If all the work performed in a round house, or any number, in a year is investigated; its causes and possible prevention learned, some surprising and valuable information will be the result. Engine failures, delays and expensive repairs are caused by a very small number of things. This, to some extent, will make less difficult, the attainment of higher efficiency. Each road has its peculiar difficulties or weak points, that will have to be overcome or strengthened in a certain way, but there are many undesirable conditions, existing to a similar degree on nearly all roads. In many instances there are instructions issued on railroads, that would do much good if followed but they are not. We do not need any new ideas to secure better results on railroads, for if the methods and practice which has been proved to be successful on many roads were incorporated in one system and adopted by all roads, a wonderful system of transportation would be possible. This is not denying the value of invention or new ideas. In an effort to improve a system, it is the many small things, and not a few large ones, that will have the greatest effect.

It may be said: the higher officials can not personally see to the details of their department. This is true of the minor details, but anything that has caused engine failures, and is causing them, is of sufficient importance to deserve the attention of all motive power officials.

Steam Distribution With Superheated Steam

Details of Ingenious Experiments Made By French Engineers in the Use of Rotating Valves

The definite use of the superheater in order to improve the effectiveness of steam in locomotives is of comparatively recent date, having been introduced about 1900. According to Rafford, the idea of superheating steam originated with a mechanic, Francois Becker, who, in 1829, took out a patent for the first superheater on record. Three years later, in 1832, Trevithick took out an English patent for a vertical boiler with a superheater. The principle of construction of superheaters as they are now made, is set forth in a patent issued to Quillacq and Monchenil, 1850, which showed the use of U tubes or similar elements placed in a series of fire tubes of large diameter, for the purpose of obtaining a superheat, and put into communication with collectors or headers, placed in the smoke box.

It has been the aim of builders for a long time to reduce the clearance space in the cylinder to a minimum. According to Nadal, the mere reduction of 30 per cent in the surface of the clearance space, or from an area of five times to three and a half times the surface of the piston, will secure a saving of about 10 per cent of the total steam consumption per horsepower hour; and, according to Ricour the substitution of piston for flat valves on the State Railways of France, decreased cylinder condensation by about one-quarter, when running with a cut-off at 30 per cent, with the consequent saving of 10 per cent in steam consumption per horsepower hour as noted above.

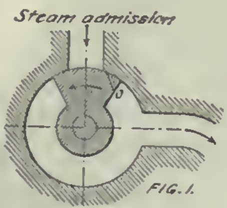
The four-valve method of distribution, which forms the majority of improved valve gears, usually effects a wide opening for both the admission and exhaust valves, with a rapid closing of the former thus avoiding wire drawing at short cut-offs. The steam passages are not bathed in exhaust steam, a fact which tends to reduce condensation on admission; the clearance space can also be made less than with the ordinary valve because of the short period of compression. These several considerations explain why the diagrams obtained with the four-valve method of distribution approach more nearly to the theoretical diagram than those of the ordinary method, and produce an increase of work and efficiency in comparison therewith. In fact, according to M. Nadal, the steam consumption per horsepower hour, on locomotives fitted with them, is 16 per cent less than with locomotives having the ordinary method of distribution, and their speeds on levels and slight grades (except in the case of motions using a dashpot, which do not work well at speeds above four revolutions per second) can be made to exceed the latter by from 3 to 6 miles per hour, other things being equal. This method of distribution is not, however, in extensive use, because of the complications involved.

The piston valves used, in 1882, on the State Railways of France, permit the reduction of the clearance space by the use of very short ports located at the ends of the cylinders. With the ordinary link motion, giving a long compression when the cut-off is short, it is impossible to take advantage of this to any great extent, and the volume of the clearance space ought not to be more than 5 or 6 per cent of that of the cylinder, and the surface of this clearance space ought not to be more than 30 per cent of that of locomotives having a plain flat valve, and this fact, as noted above, reduces the steam consumption per horsepower hour by 10 per cent.

With piston valves it is thus possible to make the compression, to a certain extent, independent of the admission, and so to reduce it by giving the corresponding edge of the openings and the valve a helicoidal form, as well as by giving the valve stems a rotary movement, thus changing the lap and adapting it to the various running conditions.

The reduction of the period of compression, on the other hand, depends on the volume of the clearance space, which should also be reduced as much as possible for the sake of steam efficiency; for even if it is filled by compression up to initial pressure, the work done by this steam represents a loss of about 30 per cent of that done to compress it. If this volume is small, the work of compression will also be small, as well as the amount of condensation; but, the final pressure of compression should not be greater than that of admission and it is this consideration which will determine its volume. On the other hand, this same pressure ought always to be sufficient, when joined with the pre-admission, to cause an arrest of the reciprocating parts without shock. The conclusion reached by M. Dwelshauvers-Dery, as a result of his investigations with different degrees of compression, is that operation without any compression would be most economical. We may cite the case of a Van den Kerckove-Bonjour condensing engine of the Corliss type in which an admission of wiredrawn steam is used during compression as shown in Figs. 1 and 2, by means of which the period of compression was reduced to 5 per cent with a clearance space of 5 per cent as shown in Fig. 3.

With the use of the Walschaerts gear, which has been generally applied to locomotives built during the past twenty years, the period of compression increases to an important extent as that of admission decreases, running from 10 per cent. of the stroke with a cut-off at 70 per cent., to 42 per cent when the point of cut-off falls to 10 per cent.



CROSS SECTION OF ADMISSION VALVE FITTED WITH OPENINGS O. FOR THE PRE-ADMISSION OF STEAM.

PLAN OF SAME SHOWING OPENINGS O. FOR THE PRE - ADMISSION OF STEAM.

High-speeds, at which the cut-off is short, thus still further increase the compression because the back pressure at the commencement of compression is still quite high, amounting to as much as 14 lbs. per sq. in. for a speed of 5 revolutions per second.

It can be readily understood, that, under these conditions a large clearance space is necessary with the link valve gear, and that it should be still more in the high pressure cylinders of compound locomotives where the back pressure at the end of the exhaust may be 70 lbs. per sq. in. or more, though the compression may be reduced to a period of 20 per cent of the stroke. Still the clearance space should be at least 14 per cent of the cylinder volume.

By making the lap of the exhaust valves variable, by the use of a helical form and the rotation of the valve stem, it is possible to reduce the period of compression very materially, and, with it, the pressure at the end of the same as well as the clearance space, thus providing for a shorter cut-off while running. It is possible to use a considerable negative exhaust lap when running in this way. But with narrow ports and flat valves such a negative lap presents certain disadvantages, because when at mid stroke or near it, such a valve puts the two ends of the cylinder into communication with each other; so that the steam working expansively at a high pressure on one side of the piston would lose a part of that pressure in passing to the other side, where exhaust is taking place, the pressure of which will be raised by this inflow, causing a second loss of motor work. At high piston speeds corresponding to cut-offs this disadvantage is greatly reduced, even with flat valves, and disappears almost entirely when piston valves, set at the ends of the cylinders are used with an outside exhaust into separate ports which only come together at some distance from the opening, as is the case, for example, in the compound locomotives with piston valves of the Eastern Ry.

A negative lap of 0.4 in. can be given to the exhaust side of piston valves for high speed running. For full stroke, at the moment of starting, it would be advantageous, on the other hand, to use a lap of 0.2 in. There is thus a total variation of 0.6 in. which could be made between running at 75 per cent and 15 per cent cut-off, so that for each ten per cent of reduction of cut-off a corresponding reduction of 0.1 in. could be made in the inside lap.

If the actual satisfactory cut-off should be taken as lying between 35 per cent and full stroke, the limit of variations of the inside lap should be taken between cut-offs of 35 and 15 per cent.

Finally, changes in lap could be obtained by the movement of a second valve placed under the control of the engineer; an arrangement possessed of several advantages for preliminary tests, or automatically, as shown in Fig. 4, which requires no particular attention on the part of the engineer, and when, in operation, involves no moving parts.

Without being of the same importance, a certain amount of variation in admission lap would also be an advantage. We know that, with the Walschaerts and Gooch valve gears, there is a constant lead which is not always a logical arrangement. In the United States it is generally considered that, when running with a full stroke cut-off, at starting or at slow speeds, there should be no lead because at the commencement of admission, the steam chest pressure would be at once established in the cylinders, and that a lead, however short, would be of no advantage and would set up a resistance that would reduce the motive power.

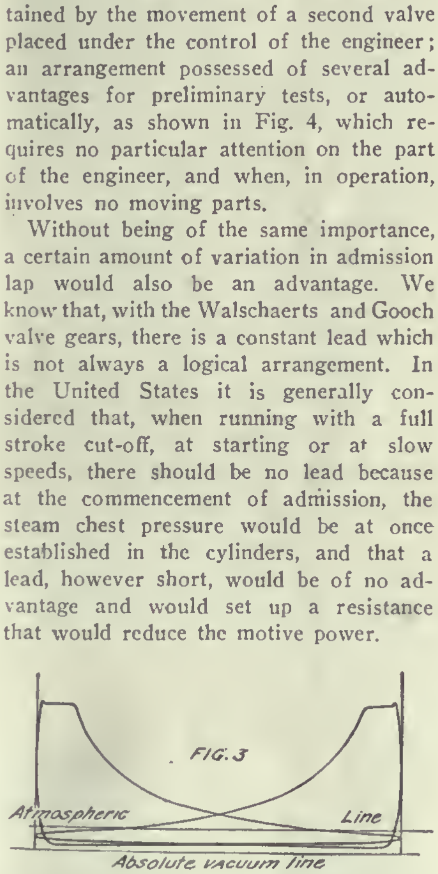


DIAGRAM OF A 300 H.P. CORLISS ENGINE, FITTED WITH THE SPECIAL VALVE OF FIGS. 1 AND 2.

At high speeds, on the other hand, a certain amount of lead is considered necessary in order to fill the clearance spaces with steam at boiler pressure at the commencement of the stroke, and thus obtain a supplementary opening of the ports without which, at short cut-offs and at these speeds, a considerable amount of wire drawing would occur, thus causing a reduction of the average pressure which would be detrimental to the efficiency and power development of the engine. From this standpoint, then, the lead could be advantageously varied from 0.04 in. or nothing for a full-stroke cut-off, to 0.16 in. or even .25 in. when the cut-off takes place at from 12 per cent to 15 per cent of the stroke. A helical outline of the lip of the valve, given a rotary movement when a change of cut-off is made would make the desired change of lead automatically.

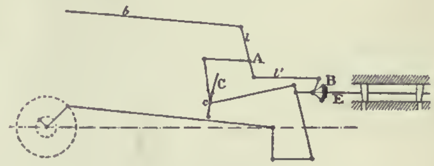


FIG. 4.

GENERAL ARRANGEMENT OF VALVE GEAR DESIGNED BY THE AUTHOR HAVING A PISTON VALVE WITH A LAP VARYING WITH THE POINT OF CUT-OFF. A—LIFTING SHAFT. B—TOOTHED SECTOR FOR ROTATING THE VALVE STEM E. C—LINK. B—REACH ROD. C—LINK BLOCK.—L—LIFTING SHAFT LEVER. L[1] —REACH ROD FOR ROTATING VALVE STEM.

Finally, it is possible to obtain for all points of cut-off, a difficult pre-exhaust and compression lap of the valves (producing, for example, a later exhaust opening and closure at once, while effecting a wider port opening at the same time), by giving the valves a helical movement, resulting from their regular longitudinal movement and a complementary rotation, produced by an articulated crank attached, at one end, to the lower portion of the lap-and-lead lever of the Walschaerts gear, and, at the other, to a small lever mounted on the valve stem.

With the different arrangements indicated above, the rotation of the valves would improve the lubrication and reduce the wear by regulating it.

M. Desdoints, former superintendent of motive power of the State Railways of France, in a study of the power and resistances developed in hauling trains, very clearly set forth the advantages of an exhaust lap that was variable with the speed and, consequently, with the point of cut-off.

"A reduction of the exhaust lap," he said, "has the effect of lowering the curve of motor effect at low speeds and raising it at high speeds." So that the best results for the different speeds of a run will be obtained by using a different lap for each of them, which can be readily obtained by the use of the hand arrangement indicated above. M. Desdoints added, apropos of the lowered efficiency of locomotives at high speeds: "A proper reduction of the exhaust lap ought to have the effect of greatly reducing, if not entirely doing away with the lowered efficiency, at high speeds." Finally, in speaking of possible running speeds, he said: "A representative diagram of the tractive effort developed for different points of cut-off, according to the running speed, will make it possible to determine the maximum speeds attainable on a given profile, for a train whose resistance is known: the intersection of the line of this resistance with the curve of tractive effort will give the speed sought. For a given engine it would be impossible to obtain more than belonged to the production of the boiler; but a reduction of the exhaust lap, causing an elevation of the curve of mean effective pressure, should raise the limit of possible speeds.

The use of admission valves with a variable lap would then be a logical thing to use and would secure, at the same time, an increase of efficiency and an improvement in mechanical action. As the superheated steam at high pressure, owing to its high speed of flow, permits the use of short cut-offs of from 12 to 15 per cent and renders the reduction of compression possible, so that compounding can be dispensed with and simple expansion is thoroughly justified; a point the desirability of which is conceded by all engineers.

The improved methods of distribution with saturated steam, will be as economical as compound operation with a flat valve. The advantages and disadvantages of compound operation taken from a comparison of the consumption of sensible and condensed steam in a compound and a single expansion engine, have been set forth by Mr. Vadal, as follows:

The ratio of expansion is usually higher in the first than in the second, except when the latter is fitted with a four-valve distribution, or generally speaking as the compression is reduced, and this is a benefit, but, on the other hand, there is a loss of area in the compound diagrams because of the transference of the steam, through the receiver, from the high to the low pressure cylinder, and the fall in pressure, which increases with the speed that results. If we look at a totalized diagram of a compound engine, we will see that the admission line of the low pressure cylinder is very much below the exhaust line of the high pressure cylinder, and that a considerable area is thus lost, a loss that has no equivalent in a single expansion engine. This loss, due to transference, is much greater than the advantage obtained by the increase of expansion and results in a greater consumption of sensible steam per indicated horsepower in the compound engine. For example, at a pressure of about 170 lbs. per sq. in. with the cut-off ranging from 10 to 20 per cent of the stroke, the ordinary locomotive uses from 12.5 to 16 lbs. of sensible steam per indicated horsepower hour, while the compound, between 30 and 50 horsepower, uses from 15 to 17.5 lbs., an increase of about 1.5 lbs. per horsepower hour. At a ruling pressure of 210 lbs. per sq. in. this increase is only about 1.4 lbs. It, therefore, increases as the pressure decreases.

On the other hand, in the compound system, where the expansion is divided between the two cylinders, the amount of steam condensed per horsepower hour is notably less, that is, it is about one-half because it is proportional to the variation in temperature in the high pressure cylinder. The actual advantage of the compound system lies in the difference between the lessening of condensation and the increase in the use of sensible steam. It can readily be seen that this difference may not always be a positive quantity. It may, in fact, be negative if the ruling pressure is too low, that is to say, below 140 lbs. per sq. in., provided the speed of rotation, at the same time, is less than three revolutions per second.

But, for high pressures, there is a positive net gain. For the same average pressure, under ordinary running conditions, compounding effects a saving of from 5 to 6 per cent with a pressure of 170 lbs. per sq. in. If the pressure is raised to 210 lbs. the saving will be from 8 to 9 per cent.

In locomotives having four valves, as great a ratio of expansion can be used as in the compound without having, as in the latter, any special loss in the amount of sensible steam used. But the losses by condensation can only be reduced by reducing the area of the clearance space and the period of compression, which is the essential characteristic of the improved method of distribution. The saving effected in comparison with a single expansion locomotive using a plain flat valve is almost as great as that obtained by compounding.

These conclusions are based upon the result of tests made in service on the State Railway of France on high speed trains, with a State locomotive having piston valves and a Ricour valve gear working under a pressure of 200 lbs. per sq. in. and a four-cylinder compound Midi locomotive using the same steam pressure. The boilers of the two engines were of the same power and they had practically the same weight on their axles. In summing up the matter, Mr. Desdouits says:

"For ordinary express service, the two types of engines develop the same amount of power, but the single expansion locomotive is the more economical of the two.

"For high speed and extra high speed, that is, for trains running at a speed of 62 miles an hour, the single expansion machine holds its own in work done and economy of operation.

"For exceptional work on steep grades or where the weight of the trains is up to the available tractive effort, the compound locomotive will develop more power and will have a lower steam consumption than a similar single expansion engine. But with suitable diameters of drivers the single expansion engine will hold its own."

In the above tests the water consumption of the locomotives having the Ricour gear dropped to 18.6 lbs. per horsepower hour, with a coal consumption of 2.4 lbs., confirming, as Mr. Desdouits says, the efficiency of these engines when working a fast schedule and making from four to five revolutions per minute.

By permitting a reduction of the area of the clearance space, together with a reduction of the period of compression, the use of piston valves having an inside and outside lap that is variable with the point of cut-off, the thermic and mechanical efficiency of these locomotives can be still further improved. Finally with superheated steam, which is favorable to the use of the short cut-offs that are possible with high pressures, a most satisfactory general efficiency can be obtained with a valve mechanism quite as simple as that used in the compound system.—*L. Pierre-Guedon in Le Genie Civil.*

Foremen the Top Sergeants of Industry

The fine sense shown by the Executive Committee of the Central Railway Club, Buffalo, in selecting an extract from the author of "Top Sergeants of Industry" for discussion at the November meeting, is worthy of imitation not only at a time when there may be a dearth of contributors, but at all times when matter that is calculated to give food for thought can readily be found by those who have eyes to see and ears to hear. The matter selected to present to the members of the club referred particularly to the character and position of the foreman and is so applicable to present conditions that a reproduction of some of the extracts cannot fail to be of interest to our readers generally and to shop men particularly:

"In these days of acute labor dissensions it is pleasant to announce that there is at least one thing on which virtually all men in industry are of one mind and about which there is entire agreement. This is the strategic importance of the foreman. All along the line there is a lively awakening to the fact that the first tidal wave of employee representation has had a tendency to submerge this key man of industry and obscure his peculiar relation to production. There seems to have been an unconscious inclination to have our eyes entirely filled with the figure of the worker, the private of the industrial army. This is not an implication that all employers have overlooked the foreman and left him out of their calculations. It is only fair to say that some of the employers who have given employee representation most careful attention have also retained the keenest appreciation of the foreman's importance as the contact point between management and men; but it is also a fact that a considerable number of employers have been swept off their feet by the rush of sentiment for dealing direct with the workers, and have lost their balance with respect to the foremen. There has been much spirited flirting with privates of the lathes and drill presses, to the temporary neglect and embarrassment of the employer's steady, the 'Top Sergeant of Industry,' the foreman.

"The character of the foreman under whom a man works is the big consideration; it is that element that holds a man in his place or decides him to look elsewhere for work. No amount of personal interest of the organized, machine-made type will make you or me or the man in the street work for or with a foreman, boss or immediate superior who delegates the human touch to another department of the big organization behind him. The man whose orders we carry out and to whom we are responsible stands to us as the company, as our employer.

"When you say that the foreman is the contact point between management and labor you make use of the most expressive and illuminating figure of speech that you could possibly employ. Let us use that comparison and say that a foreman who is not qualified by temperament, education and right training for his position becomes a non-conductor at the contact point and stops the flow of the current right there.

"The net of the whole foremanship matter is that it is scarcely possible to exaggerate the strategic importance of the foreman and that any plan that does not take this fact into consideration for all that it is worth is figuring without the largest factor in the whole situation. Any plan that places the most stress on the foreman, his character, his temperament, his education and his proper training, is the soundest and will yield the largest results.

"It was not until the great pressure for production and the wild scramble for men began that the human side of the labor problem loomed up in its real proportions. And the commanding figure that this change of vision has brought into sharp relief is the foreman. A sudden realization came to the men in the high places of management that the foreman was the man who had to handle the human element of production—that most sensitive and difficult of all industrial elements. Management was also compelled to see that the average foreman, if he kept pace with the requirements of his position, had to do an amount of work and discharge a volume of responsibilities big enough to demand the best energies of two or three good men. Management, observes a high and able official of a big company, is almost universally to blame for the fact that it has not itself realized the bigness of the foreman's job and that it has not shown the foreman himself how big the job is. As most foremen are picked workers who have been promoted from the ranks it is natural that they should be uneducated in many of the executive problems with which they must deal in their supervisory capacity. This is the real big task of today—to supply that education.

"My own observation is that it is a waste of time to drill foremen in scientific management. Production is the religion of any good foreman. The thing to do is to get the foremen together in frequent and regular meetings, drive home to them on all occasions the fact that they have a big vital job and that unless they measure up to it results will speak for themselves. Foremen should go to the mat together about the right and the wrong way to do everything that has to be done. The result will be that the weak ones who have nothing to offer or who put forward impracticable or inefficient plans are soon weeded out.

"Special pains should be taken each day to see that the men thoroughly understand their instructions. That is the one big job of the foreman. In the old days a man was told to do a certain piece of work, and every one took it for granted that he knew enough to carry out the briefest of instructions, but it was found later, and this may be true in places still, that he did not understand. That day, if not gone, is about gone in every shop worth while. The thing to do is to see that the workman not only understands his instructions, but if he has not a proper understanding of how to perform the task assigned to him, there should be a sufficiency of supervision to show him.

"The old traditional type of foreman—the shop autocrat and driver—is a menace whose possibilities for mischief and harm have multiplied under reconstructed labor conditions. On the other hand, a really reconstructed foreman who is in close sympathy with the changed attitude of management has powers for good and for constructive leadership that can scarcely be exaggerated. He is the man who must make the workers understand that the management looks upon them as economic partners in production. The foreman is the man who must get the message across to the workers or it will never be delivered to them. If he does not interpret this attitude to them in his own attitude, then he will act as a standing discount of the company's policies. Unconsciously, perhaps, he will give the lie to all the attempts that the official heads of the company may make to establish a genuine spirit of co-operation between the men and the management.

"Ever since industry expanded and delegated authority grew into a big system the worker has always looked to the foreman as the personification of management. Employee representation may modify it, but the worker will never understand the relation between worker and management until the foreman is a practical and living embodiment of right principles. Of course, it is not intended that industry is going to scrap its foreman and attempt to solve the problem by picking a full set of new ones from the ranks of the worker. It must go at the job sanely and justly and do its level best to educate its faithful and intelligent foremen to the new view point."

"The attitude of the foreman should be to make intelligent and kindly supervision so common that the workers will expect it instead of the other thing. He should welcome the opportunity to explain to a workman just how to do a piece of work and also welcome a suggestion from a worker as to how a job might be done to better advantage, in other words, instead of assuming the attitude that the men are working under him so conduct himself as to have the men work with him.

"Let no one draw the inference that this is an assault on the foreman. It isn't. The foreman has always had the hardest job in industry—and he still has it. The burden of production rests squarely upon his shoulders. He must turn out the work or be turned out himself. He must keep his men with him and at the same time give results to the management. He has had to cope with every kind of difficulty that imagination could suggest—with ignorance, stupidity, malicious cunning and shiftlessness. This kind of grind has had a tendency to sharpen his suspicion, wreck his disposition and to make him a driver rather than a leader and teacher. His load of responsibility has put a high pressure upon every moment of his shop time. In addition to this the average foreman has been trained in the school of drive. He is the product of a system that has suffered a radical change of base. His position as the contact point between management and labor makes it natural that he should be the last man to get a broad vision of the great change in employment relations. He is too close to the work, too deeply buried in its details to catch the broad general vision and observe elemental changes and tendencies. The men above him and below him have beaten him to it. The workers have realized their power to demand more intelligent and less arbitrary treatment, and in hundreds of cases the higher executives have realized the justness of that demand. In short, the two extremes have come to see that a readjustment of relations between management and labor is necessary and inevitable and in the line of man to man justice.

"The big job is to educate the workers, to stimulate them to do more thinking and to do it on the basis of a broader and more accurate knowledge of the facts and of the fundamentals in business economics.

"The place to begin that education is with the foreman. From him it will naturally percolate to the worker. Certainly it will do so if he is a real foreman in the modern sense of the term. And if he isn't he should be made so or displaced."

Items of Personal Interest

R. R. Young has been appointed general foreman of the Ft. Smith & Western, with office at Weleetka, Okla.

C. E. Bingham has been appointed supervisor of mechanical examinations on the Michigan Central, with headquarters at Detroit, Mich.

E. H. McCann has been appointed master mechanic of the eastern division of the Chicago, Great Western, with office at Stockton, Ill.

J. W. Reams has been appointed master mechanic of the Atlantic Coast Line with headquarters at Savannah, Ga., succeeding F. P. Howell, promoted.

F. S. Hammond, general storekeeper of the Pittsburgh, Shawmut & Northern, has been appointed purchasing agent in addition to his other duties.

R. R. Brain has been appointed purchasing agent of the Kansas City Southern, with headquarters at Kansas City, Mo., succeeding G. W. Bichlmeir.

R. R. Woody has been appointed master mechanic of the Chesapeake and Ohio of Indiana, with headquarters at Peru, Ind., succeeding H. C. Gillispie, transferred.

William Monroe has been appointed erecting shop foreman on the Chicago & Alton, with headquarters at Bloomington, Ill., succeeding I. W. Hicok, promoted.

Paul B. Spencer, assistant engineer of structures of the New York, New Haven & Hartford, has been appointed engineer of structures,, succeeding W. H. Moore, deceased.

F. S. Lowe has been appointed assistant master mechanic of the Canadian National Railways with offices at Montreal, Que., succeeding John M. Kerr, transferred.

G. N. Prentiss, chemist on the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., has been appointed engineer of tests, with headquarters at Milwaukee.

G. H. Walder, assistant purchasing agent of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, has been promoted to purchasing agent, succeeding W. A. Linn.

H. C. Gillispie, master mechanic of the Chesapeake & Ohio, with headquarters at Peru, Ind., has been transferred to a similar position at Huntington, W. Va., succeeding W. S. Butler.

E. W. Grice, manager of purchases, stores and safety of the Chesapeake & Ohio, with headquarters at Richmond, Va., has been appointed assistant to the president, with headquarters at Richmond, Va.

F. P. Howell, master mechanic of the Atlantic Coast Line, with headquarters at Savannah, Ga., has been appointed shop superintendent at Waycross, Ga., succeeding J. E. Bragdon, promoted.

M. Sheffer, road foreman of engines on the Chicago Great Western, with headquarters at St. Paul, Minn., has been appointed trainmaster, and as previously noted A. K. Rowe succeeds Mr. Sheffer.

I. W. Hicok, erecting shop foreman on the Chicago & Alton, with headquarters at Bloomington, Ill., has been promoted to superintendent of shops, with headquarters at Bloomington, succeeding J. J. Carey.

H. L. Worman, assistant superintendent of motive power of the St. Louis-San Francisco, has been appointed superintendent of motive power, with headquarters at Springfield, Mo., succeeding C. C. Higgins, deceased.

A. E. Smith, master car builder of the Union Tank Car Company, has been elected vice-president of the company, with superintendence of construction and maintenance of plant and equipment, with headquarters at New York.

Walter F. Rogers has been appointed district representative of the Norton Company, Worcester, Mass., with offices at 241 North Pennsylvania avenue, Indianapolis, Ind., having special reference to the grinding machine division.

W. F. Turner, vice-president of the Spokane, Portland & Seattle, with headquarters at Portland, Ore., has been elected president, succeeding L. C. Gilman, who has accepted the position of vice-president of the Great Northern.

J. E. Bragdon, shop superintendent of the Atlantic Coast Line, with headquarters at Waycross, Ga., has been appointed superintendent of motive power, second and third divisions, with headquarters at Waycross, succeeding D. M. Pearsall, transferred.

C. W. Adams, general foreman of locomotives on the Michigan Central, with headquarters at St. Thomas, Ont., has been promoted to superintendent of shops, with jurisdiction over the locomotive department, and with headquarters at Jackson, Mich., succeeding W. C. Bell, transferred to Bay City, Mich.

S. T. Gallaway has been elected president of the Elvin Mechanical Stoker Company, and A. G. Elvin, vice-president. The company has been substantially financed and a contract has been entered into with the American Locomotive Company, who are accepting contracts for the manufacture of the Elvin stokers at the company's works at Schenectady.

N. H. Harland, formerly in the service of the Bureau of Valuation of the Interstate Commerce Commission, has been appointed senior railway signal engineer for the Bureau of Safety, succeeding George E. Ellis, with headquarters at Washington, D. C. Mr. Harland will have charge of the signal, electrical, telegraph and telephone matters in the Eastern District.

Hugh Pattison, has joined the staff of the heavy traction railway department of the Westinghouse Electric & Manufacturing Company to make special engineering studies under the direction of F. W. Shepard, director of heavy traction. Mr. Pattison has already had a wide experience in electric construction work, and during the war period was engaged as assistant to the general manager of the Remington Arms Company.

C. H. Jackson has been appointed sales agent of the Pressed Steel Car Company, and Western Steel Car & Foundry Company, western district, with headquarters at Chicago. Previous to the war period, when Mr. Jackson was commissioned as a second lieutenant in the Air Service, he had a wide experience in the mechanical engineering departments of the American Bridge Company, and latterly with Joseph T. Ryerson & Son.

John A. Talty, assistant superintendent of equipment and equipment inspector for the New York Public Service Commission, Second District, has accepted the position of special engineer with the Franklin Railway Supply Company, New York. Mr. Talty has had much experience in the mechanical and transportation department of railroads, as well as in educational work as air brake instructor on railroads and latterly with the Scranton Correspondence School. In 1910 he entered the Public Service Commission inspecting locomotives and rolling stock equipment.

C. M. Harris, Manager of the Railroad Shop Section, Industrial Department, Westinghouse Electric & Manufacturing Company, has been appointed vice-president of the Hagerstown and Frederick Railways Company, which operates interurban railways and central stations in Maryland. Mr. Harris was graduated from Pennsylvania State College in 1901, as an Electrical Engineer. After filling various positions with the Pennsylvania and the Baltimore & Ohio Railroads, he became Master Mechanic of the Washington Terminal Railroad, from which he went with the Westinghouse Company to handle the electrical business of railroad shops. Mr. Harris was made manager of the Railway Shop Section, Industrial Department, last spring.

OBITUARY

C. C. Higgins

The death is reported of C. C. Higgins, superintendent of motive power of the St. Louis, San Francisco, by the accident of an extra freight train running into his car at Racine, Mo., on November 3. Mr. Higgins was a graduate of the University of Illinois, and was a fine type of the western railroad man, polished by education and broadened by experience.

Donald G. Stuart

Donald G. Stuart for over forty years employed in the service of the Eastern Railway Association, died in office of the Association at Washington, last month. Mr. Stuart was appointed Secretary in 1918, which office he held at the time of his death.

Arthur M. Waitt

Arthur M. Waitt, for some time superintendent of motive power of the New York Central, died November 11, at Sharon, Conn., in his sixty-third year. Mr. Waitt was a graduate of the Massachusetts Institute of Technology. Mr. Waitt had a wide experience as a constructing engineer, and since 1905 was engaged as an engineering specialist in railway work.

Charles Smith Clarke

The death is announced of Charles Smith Clarke, formerly vice-president of the Missouri Pacific Railway, in his 59th year. Mr. Clarke was born in Frederick, Md., in 1862; and entered railroad service as a machinist apprentice in 1879 with the Illinois Central Railroad at Chicago, Illinois. His promotion was rapid, first as a mechanical draftsman and afterwards as secretary to master mechanics on the Chicago, and Middle Divisions of the Havana and Rantaul divisions of the Illinois Central Railroad. In 1890 he accepted an appointment as division superintendent of the Mobile & Ohio railroad at Mobile, Ala. In 1899 he was promoted to general superintendent. In 1902 his supervision was extended to embrace the Mobile & Bay Shore lines. In the same year he was elected general manager of both roads. In 1904 he resigned to become vice-president of the Missouri Pacific Railway. He was a capable and energetic railroad official, unusually popular, both with railroad officials and that larger class of railroad men from which he sprung.

Tractor Hauls a Mogul

Utilizing a gasoline tractor to tow a big mogul locomotive that had become "stalled" for lack of water on the Pere Marquette railroad tracks near Blenheim, the train crew saw a "little giant" back up against the tracks, couple up to the huge iron horse and then quietly draw it to the life-saving water tank. So far as known, this is the first time a tractor has been called upon to perform such a feat.

American Society of Mechanical Engineers

From the programme of exercises at the first annual meeting of the American Society of Mechanical Engineers held in New York, December 7-10, 1920, the subject of transportation seemed to be the keynote of the four days' meeting. The following subjects are on the programme of the various sections in session as we proceed to press.

FUEL SECTION.

Fuel Supply of the World, L. P. Breckenridge.

Low-Temperature Distillation of Coal, O. P. Hood.

Fuel Conservation: The Need for a Definite Policy and Its Requirements, D. M. Myers.

Form Value of Energy in Relation to Its Production, Transportation and Application, Chester G. Gilbert and Joseph E. Pogue.

FOREST PRODUCTS.

A Photographic Study of the Woodworking Industry, F. F. Murray.

Engineering in Furniture Factories, B. A. Parks.

Use of Wood in Freight-Car Construction, H. S. Sackett.

Machining Railroad Cross-Ties, D. W. Edwards.

Creosoted Wood-Block Factory Floors, L. T. Ericson.

Processes and Equipment Used in Wood Preservation, E. S. Park and J. M. Weber.

Electrically Driven Saw Mills, A. E. Hall.

MACHINE SHOP SECTION.

Side-Cutting of Thread-Milling Hobs, Earle Buckingham.

Cylindrical Grinding in 1920, W. H. Chapman.

Mechanical Engraving and Die-Sinking, J. F. Keller.

On Wednesday afternoon the Railroad Section will have the following program: Three papers are to be presented, as follows:

Modernizing Locomotive Terminals, G. W. Rink, assistant superintendent of motive power, C. R. R. of New Jersey.

Increasing the Capacity of Old Locomotives, C. B. Smith, mechanical engineer, Boston & Maine R. R.

Static Adjustment of Trucks on Curves, R. Eksergian, engineer of the Baldwin Locomotive Works.

The first two papers mentioned will furnish abundant opportunity for a discussion of practical problems for keeping the locomotives in service a greater part of the time. The introduction of modern labor-saving facilities for economy in repairs and rebuilding will be brought out and constructive measures considered. Mr. Eksergian's paper considers the technical points in the design of a locomotive from the aspect of the adaptation of the running gear to a plane curve. The paper is extremely valuable and presents material not on record in any of the technical works on this subject.

On Thursday, the 9th, the most important features of the transportation question will be discussed, the programme for the morning session being as follows:

Railroads, Daniel E. Willard, president, Baltimore & Ohio Railroad.

Railroad Feeders, Charles A. Morse, chief engineer, Chicago, Rock Island & Pacific Railroad.

Waterways, General Frank T. Hines.

Motor-Truck Transportation, Francis W. Davis, engineer, Pierce-Arrow Motor Car Company.

At the afternoon session Terminals will be discussed as follows:

Terminals, Col. William Barclay Parsons, consulting engineer, of New York City.

The New York Terminal Problem, Gustav Lindenthal, consulting engineer, of New York City.

The meeting is in many ways the most important that has been held among American Mechanical Engineers in so far as the bearing on transportation questions is concerned.

Books, Bulletins, Etc.

THE HANDBOOK OF INDUSTRIAL OIL ENGINEERING, by John Rome Battle, M. E. Published by J. B. Lippincott, Philadelphia. 131 pages, flexible cloth, profusely illustrated.

A compilation of data for many years by an expert engineer comes at a time when the world faces an era of great manufacturing activity and keen competition. Efficient operation of mechanical equipment is the need of the hour. Correct selection and efficient use of lubricants is a primal necessity. This notable book meets the situation admirably. Briefly it may be said to cover the entire field, and with the world's present shortage of petroleum and consequent high prices, the latest and best information on the subject should be available to every one. This work offers many suggestions of real value that cannot fail to be of great assistance in effecting economies in the operation of industrial equipment, and in reducing wastage. Locomotive lubrication is treated in detail in a special section and shows how thoroughly the accomplished engineer and author has mastered the subject. The same may be said of the air brake, and, indeed, all of the vast number of subjects treated.

LESSONS IN MECHANICS. LESSONS IN ELECTRICITY AND MAGNETISM. LESSONS IN HEAT. Three text books for colleges and technical schools, by W. S. Franklin and B. MacNutt. Published by Franklin and Charles, Bethlehem, Pa.

These three books have been arranged to meet the needs of the two-year schedule in elementary physics which have been recently adopted in some of our technical schools. The central idea underlying these new texts is that mathematical training must be accomplished by the combined efforts of teachers of mathematics and teachers of physics, and will greatly facilitate class-room work. Material of real value has been reduced to a minimum. Illustrative problems are added. The arrangement and general logical sequence of the works are admirable, and the books cannot fail to meet with much popular approval.

Baldwin Record No. 99.

There are twenty-nine illustrations of eight-coupled locomotives for freight service in Record No. 99 of the Baldwin Locomotive Works, ranging from a total weight of engine and tender of 304,000 pounds of the Consolidation type of locomotive in service on the Union Railroad, to that of 560,000 pounds of the Mikado type in operation on the Atcheson, Topeka and Sante Fe Railway. The frontispiece shows a Mikado type locomotive in service on the Virginia Railway, the rating for these locomotives being 100 loaded cars, averaging 7,850 tons total weight, the maximum ascending grade to be negotiated being 0.2 per cent. As is well known the Mikado type of locomotive is a development of the older type of Consolidation, the principal variation being in the larger firebox of the Mikado type, necessitating the introduction of a truck under the firebox and was originally designed to burn an inferior grade of fuel. The marked success of the Mikado type is largely due to its high steaming capacity. Superheaters are almost invariably applied to new locomotives of both these types, and the large locomotives of the Mikado type and many of the Consolidation type are equipped with mechanical stokers, besides all other modern improvements.

Lubrication.

The Texas Company's house organ, *Lubrication,* improves month by month. The policy of the editor seems to be to take the more important industries one by one, and after giving a brief outline of the mechanical procedure in manufacturing, a discussion following the lubricating problems involved. In this way much has been already accomplished that is of real value and the future full of promise. As is well known, oils and greases are almost universally compounded from empirical data, and the best products are manufactured by those having the greatest experience and best facilities. The Texas Company seems determined to get away from rule of thumb methods. Copies may be had free on application by engineers, master mechanics, executives of manufacturing or power using concern, or purchasing agents. Address, 17 Battery place, New York.

Accident Bulletin.

The Interstate Commerce Commission, in addition to furnishing complete data of collisions, derailments, and other accidents resulting in injury to persons, equipment or roadbed, ensuing from the operation of steam roads during the three months ending on December 31, 1919, also furnishes a summary of the entire year, from which it is particularly gratifying to observe that the effect of the Safety movement is manifested in an eminent degree. Bulletin No. 74 may be said to mark a new period in the safety of human life. It is the lowest record in twenty years in the list of fatalities, and the lowest record in ten years in the list of injuries. Indeed, if it were not for the growing list of accidents directly attributed to the mismanagement of automobiles, the report would be much more gratifying. The Bulletin is a mine of information and copies may be had from the Government Printing Office, Washington, D. C.